NASA Magazine

spring 1993

from the administrator

NASA depends on the educational system to produce a skilled and knowledgeable workforce. Schools, in turn, use the space program to motivate and encourage students to study science, engineering and math.

As someone who came from a family of educators, including my father and sisters, I have always felt a civic responsibility to promote educational activities. One of my highest priorities as NASA Administrator has been to encourage the agency to do more in education, believing that we have a unique ability to capture the attention of our nation's youth.

Since the inception of the space program, NASA and America's schools have traveled parallel paths. We share the same goals—exploration, discovery, and the pursuit of new knowledge—and we need each other. NASA depends on the educational system to produce a skilled and knowledgeable workforce. Schools, in turn, use the space program to motivate and encourage students to study science, engineering, and math.

I've seen it happening across the country. I have visited schools from coast to coast, and I've met with the full spectrum of students, from pre-school to graduate school. They are excited about learning when space is part of the curriculum.

The most outstanding example I have seen is in Cleveland, Ohio at the Anton Grdina School *(see cover story, pg. 10)*. America's future is to be found in this unassuming school surrounded by a public housing project. I spent a full day at Anton Grdina, exploring the halls and visiting classrooms. I saw young children excited about math, science, reading, and nutrition, and for each subject, space was the catalyst to help them understand.

Touring Space Station Harmony, one couldn't help but share in the pride of the students, teachers, and parents who made it a reality.

The staff at NASA Lewis Research Center is to be commended for leading this effort. It is my hope that Anton Grdina will serve as a model for other schools to follow.

In closing, as I reflect upon my experience at Anton Grdina, I am reminded of a statement made by Dr. Alan Keys of Alabama A&M: "People forget what may be the most pressing human need of all—the need for a sense of purpose and meaning in life that goes beyond this moment and that links us with a future larger than ourselves. As long as children dream dreams inspired by that sort of meaning, they may live in poverty, but poverty never lives in them."

CONTENTS

spring 1993

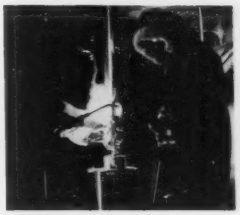
Cover: Astronaut Charles Bolden talks to student-astronauts while touring "Space Station Harmony" at the Anton Grdina Primary Achievement School in Cleveland, Ohio last October.

features

10
GIVING CHILDREN SPACE TO GROW
Lewis Research Center uses the lure of outer space to help kids learn.

18
ANTARCTIC ADVENTURE
Exploration can be a risky business.

23
TAKING IT TO THE STREETS
NASA comes face-to-face with its "customers."



26
WE FREEZE TO PLEASE
Researchers at Lewis Research Center are learning more about the dangers of airplane icing.

31
EULOGY FOR A PIONEER
The Pioneer Venus orbiter surpassed all expectations for its mission.

departments

2 Spectrum

7 Down to Earth

8 Inside the Beltway

9 Off Hours

34 Center Select

36 As I See It

37 Countdown

NASA MAGAZINE

Acting Associate Administrator for Public Affairs
Geoffrey H. Vincent

Acting Manager of Internal Communications
Beth Schmid

Editor
Beth Schmid

Editorial Consultant
Tony Reichhardt

Editorial and Production Assistant
Sonja Alexander

Design
Steve Chambers

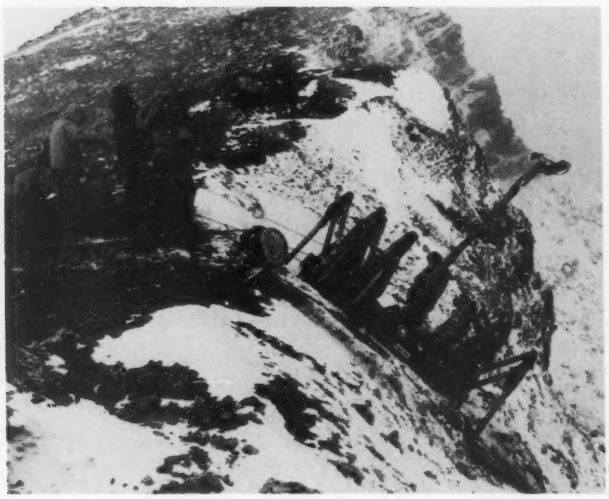
Art Director
Robert Schulman

Staff Photographer
Bill Ingalls

NASA MAGAZINE is published quarterly by the National Aeronautics and Space Administration for the information of the Agency's employees. Contributions and comments are solicited from Headquarters and all field centers, and should be addressed to Editor, NASA MAGAZINE, Internal Communications, Code P-2, NASA Headquarters, Washington, DC 20546.

NASA MAGAZINE is for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402

NASA MAGAZINE is printed on recycled/recyclable paper.



Photo/Dave Lavery

Dante begins the crawl into the inferno of Mt. Erebus as researchers closely monitor its progress.

Home Sweet Home

After dangling at the lip of an inferno, Dante, the eight-legged robot, returned to the United States with a team of NASA and university researchers in January after a month-long stay in Antarctica. The highlight of the expedition came when Dante crawled 6.3 meters down Antarctica's Mt. Erebus, an active volcano, before a severed fiber optic communications cable halted the mission. Although Dante did not explore the volcano fully, it did prove that similar robots can play an important role in future planetary exploration.

"The mission is an unqualified success in terms of the telerobotic aspects," NASA project supervisor Dave Lavery said. Goddard Space Flight Center operators were able to control the robot by satellite, much as they would a rover on Mars or the Moon. With these first steps, Dante also demonstrated that robots could perform in an environment as harsh as Antarctica's.

Kicking Off the New Year

NASA's first Space Shuttle mission of 1993, STS-54, ended successfully January 19 when the orbiter Endeavour glided to a smooth runway landing at the Kennedy Space Center. The crew—Commander John Casper, Pilot Don McMonagle and Mission Specialists Mario Runco, Susan Helms and Greg Harbaugh—said later that they were pleased with the work they accomplished during their time in space. Early in the flight, the crew released the Tracking and Data Relay Satellite-F from Endeavour's cargo bay, which was re-named TDRS-6 once in orbit. The new bird will be a ready spare for the TDRS satellites now providing continuous communications for Space Shuttles and other NASA satellites in geosynchronous orbit.

In spite of a slow start, the Diffuse X-ray Spectrometer experiment took in nearly 14 hours' worth of data through its port detector in Endeavour's payload bay, and more than eight hours through its starboard detector. Runco and Harbaugh also completed a 4-hour, 28-minute space walk designed to help prepare crews, trainers and controllers for the assembly and maintenance of the Space Station in the late 1990s.

During their last full day in space, the STS-54 astronauts successfully restarted a fuel cell in orbit for the first time. In the Space Station era, the Shuttle will be docked to the station for a month or more at a time, which will require a power-down of Shuttle fuel cells that produce electrical power.

Steadiness Study

When astronauts return to Earth after several days of being weightless, they typically suffer from temporary light-headedness. A new study at the Ames Research Center is searching for ways to prevent this from happening on future space flights. Joan Vernikos, who heads Ames' Life Science Division, says that reduced levels of blood

Photo/JSC

The STS-54 crew, clockwise, Susan Helms, Mario Runco, Jr., John Casper, Donald McMonagle and Greg Harbaugh, aboard the Space Shuttle Endeavour.

plasma are believed to contribute to an astronaut's tendency to feel faint on returning to Earth. The study compares the effectiveness of two procedures for expanding plasma volume in test subjects following a period of head-down bed rest to simulate the body fluid shift that takes place in microgravity.

The study involves six women and six men, ages 30 to 50. Plasma volume is measured under three conditions: after taking water and salt tablets, after taking a synthetic steroid similar to steroids normally found in the body, and after no medication. Vernikos will measure the effectiveness of both treatments during the day and at night.

Make It Fun

As part of NASA's celebration of African-American History Month in February, Shuttle astronaut Fred Gregory gave a standing-room-only presentation at Headquarters, advising his young audience to "plan now to have fun when you're an adult." The groups of local students who had come to take part in a NASA-sponsored essay contest listened intently as Gregory described his extraordinary career. The first African-American to serve as a Shuttle commander, he has spent 455 hours in space on three different missions and logged more than 6,500 hours flying more than 50 types of aircraft, including 550 combat missions in Vietnam. Gregory is currently the Associate Administrator for Safety and Mission Quality at Headquarters. "My goal," he explained to the students and assembled NASA employees, "was to have fun. Then you have no obstacles. When you hit an obstacle, you move aside or back up and go around."

Photo/HQ Bulletin

Fred Gregory, mission commander of Atlantis on STS-44.

A Really Big Show

Attracting nearly 6,000 people and covering 5,400 square meters of exhibit space, the "Technology 2002" conference last December in Baltimore was the largest technology transfer meeting ever held. The centerpiece of National Technology Transfer Week, the conference featured 136 symposia presentations and workshops focusing on federally sponsored technologies available for commercial use. Among the technologies represented were high-performance computing, advanced materials, microelectronics, and biotechnology.

Leading researchers from 250 government laboratories, universities and high-tech firms—representing the United States and 17 other countries—joined under one roof to sell or license their inventions and products to businesses and manufacturers. The hundreds of innovations on display at "Technology 2002" included the Data Egg, a portable device that allows a computer user to enter data with one hand while doing virtually anything else—walking, driving, reclining or even floating in space. This year's "Technology 2003" meeting will be held December 7-9 in Anaheim, California.

Raking Up

NASA and industry engineers have come up with a design for a new airflow monitoring device that will save more than $1 million on a NASA aeronautics research program. The device is a greatly improved "inlet rake" that measures the air flowing into one of the engines on the F/A-18 High-Alpha Research Vehicle (HARV) based at the Dryden Flight Research Facility. Engineers use airflow data from the HARV to help give fighter-type aircraft more power and better handling qualities.

According to Dryden's propulsion group leader, Ronald Ray, the new inlet rake is more compact and requires fewer changes to the aircraft than those used in the past. In fact, says Ray, "This new rake actually saved the [HARV] program." Most

of the million-dollar savings results from the simplicity of the device, which is centrally mounted like a wagon wheel 20 centimeters in front of the engine.

The invention may save money on other Dryden programs as well. It works on all General Electric F404 engines, so it could be installed on other F/A-18s at the facility and on the X-31 research plane with minor modifications. Dryden engineers came up with the idea for the new inlet rake and presented it to General Electric, which agreed to design and build two of the devices. The work is part of a joint effort by the Lewis Research Center and Dryden to design better engine inlets.

Hands-On

Engineers and scientists working on the redesign of NASA's Advanced X-ray Astrophysics Facility (AXAF) at the Marshall Space Flight Center are getting their first, direct in-house experience in developing a major space system since the days of Skylab. AXAF, which is planned to be launched in late 1999 as the third of NASA's "Great Observatories," will consist of two specialized, orbiting telescope systems for long-term study of X-ray emissions in the Universe.

The first spacecraft, AXAF-I (for "imaging"), will be an orbiting telescope for capturing high-resolution X-ray images and low-energy X-ray spectra of astronomical objects. The second mission, AXAF-S (for "spectroscopy"), will concentrate on high-energy X-ray spectroscopy.

Rather than being performed by outside contractors, the AXAF-S redesign will be done in-house at Marshall.

Space Station trailers and exhibits undergo preparations for "America's Reunion on the Mall", January 17–18.

Freedom on the Mall

NASA played a part in the festivities leading up to President Bill Clinton's Inauguration Day on January 20 with the display of two Space Station Freedom modules and a tent full of NASA exhibits on the National Mall. Some 20,000 visitors out of the many thousands who came to town to participate in "America's Reunion on the Mall"—the biggest event surrounding any inauguration in U.S. history—walked through the modules, which were housed in connected tractor-trailers. A tent next to the trailers contained exhibits on Mission to Planet Earth and other space science activities, as well as models of the Space Shuttle, Hubble Space Telescope, and the Compton Gamma Ray Observatory. Also inside the tent was a single-screen version of NASA's popular World Space Congress "videowall" exhibit.

"That was so much fun!" said Headquarters Legislative Affairs staffer Toby Costanzo after volunteering to work at the exhibit. "The positive attitude of the thousands of people who visited our exhibit was an outstanding commentary on NASA."

Be Prepared

More than 250 Langley Research Center engineers, scientists, technicians and support personnel left their offices and labs in February to visit schools in the Hampton Roads, Virginia, area as part of National Engineers Week. The Langley employees taught 800 classes in 12 local school districts during the week of February 14-20, emphasizing the importance of studying math and science for success in an increasingly technological world. More than half the Langley volunteers had attended an educational workshop to learn how to get students involved and hold their interest—tips they then shared with fellow NASA lecturers. •

Honored

The Royal Aeronautical Society of Australia recently presented the Sir Charles Kingsford Smith Memorial Award to **Barbara Stone** of the Office of Advanced Concepts and Technology. The medal was

Dr. Barbara Stone

presented jointly to Stone, the first woman to win the award, and her co-author, Peter Kleber of the German space agency, for contributions to the promotion of worldwide commercial use of space. Stone is currently the Special Assistant for Industry Liaison in the Advanced Concepts and Technology Office.

In February, NASA scientist **Robert Watson** received the Scientific Freedom and Responsibility Award from the American Association for the Advancement of Science. Watson, director of the Process Studies Program Office in the Office of Space Science and Applications, and Dan Albritton of the National Oceanic and Atmospheric Administration were honored for their contributions to scientific and policy discussions on global ozone depletion. International scientific assessments of ozone, several of which Watson has chaired, have led to a nearly global consensus to phase out chemicals that harm the ozone layer.

Lonnie Reid, head of the Lewis Research Center's Fluid Dynamics Division, was inducted into the Ohio Science, Technology and Industry Hall of Fame in Columbus in February. Reid, the first NASA researcher in the Hall of Fame, was honored for his pioneering work in integrating theoretical and experimental methods in fluid dynamics. The science of fluid dynamics deals with the interaction between fluids and objects, such as air flowing through the

Dr. Lonnie Reid

various parts of a jet engine. Reid leads Lewis's efforts to analyze and experiment with airflows and temperatures inside advanced aerospace propulsion systems. He is considered a leading U.S. expert on turbomachinery technology.

NASA's Inventor of the Year for 1992 is an astrophysicist whose work in developing X-ray telescopes led to his invention of a revolutionary new microscope. **Richard B. Hoover** of the Solar-Terrestrial Physics Division in Marshall

Richard B. Hoover

Space Flight Center's Space Science Laboratory, was selected for his invention of the Water-Window Imaging X-ray Microscope. This instrument should enable researchers to see in great detail high contrast X-ray images of proteins, chromosomes and other tiny structures inside living cells. According to Hoover, the advance in capabilities provided by this microscope may be as great as the difference between looking at a photograph of the human body and an X-ray.

Thomas P. Stafford, a pioneer NASA astronaut who commanded the first flight of the lunar module to the Moon as well as the American crew that rendezvoused with a Soviet spacecraft in 1975, has received the Congressional Space Medal of Honor. The award—the highest that can be given for space exploration—was presented by former Vice President Quayle at a ceremony in the Old Executive Office Building in Washington on January 19. Upon receiving the medal,

Thomas P. Stafford

Stafford said, "This is the greatest honor of my life. I am very proud to have contributed to our nation's future in space and I am deeply grateful for the opportunity to have participated in the beginning of America's venture into the new and endless frontier."

Famed test pilot **A. Scott Crossfield** was awarded the NASA Distinguished Public Service Medal in January for his contributions to aeronautics and aviation over 50 years. The award was presented by Administrator Goldin in a Capitol Hill ceremony honoring Crossfield's retirement from federal service.

Gene Roddenberry, creator of the *Star Trek* television series, posthumously received NASA's Distinguished Public Service Medal in January. The medal was presented to his widow,

Majel Barrett Roddenberry, by Administrator Goldin in a ceremony at the Smithsonian's National Air and Space Museum in Washington. Roddenberry, who died in October 1991, is credited with popularizing space exploration through his original television series, six motion pictures and the spin-off series *Star Trek: The Next Generation*.

The show has had a direct influence on the U.S. space program with the naming of NASA's first Space Shuttle, Enterprise, after Capt. Kirk's famous starship. In addition, many younger people in the space program, including astronauts, cite the show as an early influence on their lives.

One such space traveler, **Mae Jemison**—the first African-American woman to reach orbit—credits *Star Trek* with arousing her interest in the sciences. In particular, Lt. Uhura, the only black woman onboard the Starship Enterprise, inspired Jemison to pursue a career as a real astronaut. Nichelle Nichols, who played Uhura on the popular program, attended rallies in honor of Jemison after her first Shuttle flight last fall, and later presented Jemison with an official limited edition 25th anniversary *Star Trek* pin and the Trailblazers Award—for first-ever achievements—at the 14th annual American Black Achievement Awards in Los Angeles.

Jemison, right, receives a Star Trek pin from Nichelle Nichols, aka Lt. Uhura.

Changing Jobs

In late December, Administrator Goldin announced the appointments of **Yvonne Freeman** as Assistant Administrator for Equal Opportunity and **Wesley Harris** as Associate Administrator for Aeronautics.

PhotoHQ Bulletin

Dr. Yvonne Freeman

PhotoHQ Bulletin

Dr. Wesley Harris

Freeman had most recently been manager of the Minority Science and Engineering Program at the Jet Propulsion Laboratory. In her new position she will be responsible for maximizing opportunities for women and minorities throughout NASA and for leading efforts to recruit and retain employees from under-represented groups.

Harris had been vice president of the University of Tennessee Space Institute in Tullahoma since 1990.

In his new position, Harris will direct research and technology development efforts supporting America's aeronautics industry.

Goldin also announced the appointment of **Geoffrey H. Vincent** as Acting Associate Administrator for Public Affairs in late January. Vincent began working at NASA in 1987 and has served as a public affairs officer and special assistant to the Associate Administrator for Public Affairs. Before his current appointment, he was director of the Program Management Division. **William Livingstone**, former Associate Administrator for Public Affairs left NASA on January 22. **Sue Richard**, former Deputy Associate Administrator for Public Affairs who also left in January, played a major role in the creation of this magazine.

Deidre A. Lee has been named Associate Administrator for Procurement. Lee had been Deputy Assistant Administrator for Procurement since September 1992. Before that, she was the executive officer to NASA's acting Deputy Administrator.

Died

Joseph George Sobala, 60, retired chief of NASA's Communications Systems Branch, died of cancer on January 29. Sobala began his career with the agency in 1963 at the Goddard Space Flight Center and held several positions in the field of communications. In 1977 he moved to Headquarters to manage the agency's communications program and was later promoted to chief of that branch. Sobala had been responsible for the global network that supports all of NASA's Earth-orbiting, deep space and manned missions as well as commercial and non-U.S. launches. •

What started as an attempt to help a friend in need may make life a little easier for thousands of people who have suffered the loss of a hand.

Marvelous Modalities

by Robert Lessels, MSFC

When a team of Marshall Space Flight Center engineers, technicians and support personnel learned that retired co-worker James Carden had lost his hand in a planer mill in 1986, they did more than just send a condolence card. They joined together to see if they could help him out and took on this biomedical applications project under NASA's overall technology transfer program.

Carden, who had the accident while working at his lumber business, found that a conventional cable-operated hook prosthesis was not strong enough to be useful in his line of work. It was too cumbersome to allow him to lift lumber—or just as importantly—to indulge in his favorite pastime of fishing. What Carden needed was a heavy-duty device with various attachments, or "modalities," connected to it that would free him to perform a broader range of activities. At the time his former colleagues at Marshall learned of his dilemma, the prosthetics industry was not manufacturing any such devices.

According to Carden's long-time friend and co-worker Jewell G. "Pete" Belcher Jr. of Marshall's Tethered Satellite System project office, "Studies have shown that the work we proposed to do for Jim could benefit many thousands of other Americans as well as uncounted others around the world. It is difficult for many of these amputees to perform tasks such as gardening, hunting and fishing, curling hair, using chain saws, working in the kitchen and innumerable other activities requiring the use of two hands."

After the Marshall team became involved, they asked Amie Bradley of nearby Arab, Alabama, who had lost her left hand in an automobile accident, to participate in the project with Carden. Both Bradley and Carden became actively involved in developing, testing and evaluating various new attachments.

As a start, they both were equipped with a new, specially modified prosthetic socket designed to accept the modalities. The team then developed a wide variety of devices for use at home and on the job. Carden wanted a heavy-duty lifting attachment to help him with his work, as well as a chain saw adapter and a fishing reel crank device. He also asked the team to come up with a device to hold carpentry nails. The answer: a magnetized attachment.

Both Carden and Bradley asked for a clip attachment for holding small objects. He wanted to hold fishing lures while he attached a line to them, and she wanted to be able to apply nail polish. Bradley found that she could use a hair dryer holder, a gripper for bowls and other cookware, a spatula-like lifting device for pots and pans, and a carving fork attachment. Both also requested a device to hold brooms and rakes.

Carden says the fishing reel crank adapter is his favorite. "Now I can still do the things I want to do and smile about it," he says. Marvin Fourroux of Fourroux Orthotics and Prosthetics Inc. in Huntsville, one of the project team members, says that most new amputees have a general feeling of frustration with a prosthesis at first. Overcoming this hurdle often requires occupational therapy, he says.

"Most amputees are restored to a certain level of function, and [they] eventually use their device daily," according to Fourroux. "The modalities developed by the Marshall team are a way of making the prosthetic device easier to use and better tailored to specific individual life styles."

When used in conjunction with therapy, these NASA-funded devices open new possibilities for individuals who have lost a hand. The Marshall team is now working with a rehabilitation facility to get several of the new devices into mass production. If they are successful, amputees all over the world who benefit from their invention will have James Carden, Amie Bradley—and NASA engineers—to thank. •

In spite of what we think we know about this new Congress, there is much more that we don't know. So we wait and watch and try to predict what will happen once the votes start being tallied.

The Waiting Game

by Dr. John Lawrence, Office of Legislative Affairs, NASA Hq.

Most of official Washington feels a lot like Butch Cassidy these days. Looking out across the prairie at the approaching posse, Butch says to Sundance, "Who *are* those guys?" As we review the roster of new names in the House of Representatives, many of us are wondering the same thing. Implied but unspoken is the more ominous rest of the question: "...and what are they going to do to us?"

When the 103rd Congress convened January 5, the first order of business was to swear in 110 new members of the House. As predicted, it was the largest turnover in the modern history of Congress. The new members also reflect the expected cultural mix. Partly as a result of congressional redistricting, 24 percent of the new members are of racial or ethnic minorities, as compared to 10.5 percent of incumbents. Twenty-one percent of the new members are women, compared to only eight percent of incumbents.

But in some ways the newcomers are a surprise. Most are political professionals rather than the "outsiders" that campaign rhetoric might have led us to expect: 72 percent have held previous elective office. As a group they also are older than expected. Only 11 percent are 36 or younger, and half are over 45.

Predicting the direction this Congress might take is far more difficult than sizing up its demographics. It appears unlikely that the newcomers will fulfill the public's expectations for reform, at least initially. The most requested committee assignment among the freshmen was Public Works and Transportation, a reliable generator of pork barrel projects. Several of the newcomers tried to organize their colleagues to help slash pork projects and perks, but the effort quickly died. And even though dozens of freshmen pledged to attend a November seminar for reforming Congress, only 15 showed up.

Regarding NASA, the crystal ball is still quite cloudy. On the plus side, the House Science Committee, which authorizes NASA programs, was the assignment of choice for one-third of the freshmen. This committee is not normally regarded as a powerful or popular assignment, so the high interest level is both significant and unique. At the same time, only three of the 110 new members who were invited to an expenses-paid "Jobs and Technology" forum in Texas (including briefings and tours at the Johnson Space Center) accepted, and all three subsequently canceled when late votes conflicted with the schedule.

Using recent votes to terminate funding for Space Station Freedom as a litmus test for support of NASA, incoming members have been about evenly split in recent years. A recent Gallup survey verifies this ratio, with 59 percent of new members wishing to retain NASA funding at existing or higher levels. If indeed the new members conform to these expectations, NASA would lose about 20 Space Station votes, since departing members from the last Congress were pro-NASA by the higher ratio of 2-1. Past victories on this issue have been by a margin of approximately 30 votes.

Clearly, the most reliable method of gauging the 103rd Congress's stance on NASA issues will be to watch its performance. The action begins this spring, when the House Science Committee holds several hearings on space issues and NASA oversight. The Senate Commerce and House Science Committees will be holding NASA authorization hearings over the same period.

The House VA, HUD and Independent Agencies Subcommittee holds its hearings on the NASA budget request in late April. By June we should have House floor action and the appropriations bill will be sent to the Senate. Conference action on both the authorization and appropriation is expected this summer. When those milestones are passed, we will have a much better idea how we stand with this new Congress as well as with the new administration. •

He's not an astronaut, but Langley Research Center's Erik Vedeler has reached heights that most people never see. What his hobby takes is a sense of adventure and an appreciation of natural beauty. A rope helps, too.

To the Top

by Michael Finneran, GSFC

As an aerospace technologist, Erik Vedeler is used to things that fly high. But airplanes and spacecraft are the last things on his mind when the 32-year-old Langley Research Center employee goes looking for off-hours excitement. To reach his natural high, Vedeler goes mountain climbing. Big-time.

In 1990, he scaled Alaska's Mount McKinley, at 6,200 meters, the highest summit in North America. While visiting a friend in South America in the mid-1980s, Vedeler climbed Peru's 5,800-meter Nevado Pisco. He's also been to the top of three volcanic peaks in Ecuador: Chimborazo, which is 100 meters taller than McKinley, and Cayambe and Cotopaxi, which both top 5,700 meters.

"I started climbing in the mid-1970s as a teenager," says Vedeler, who works in the Guidance and Control Division of Langley's Antenna and Microwave Research Branch. "My uncle was a big-time climber who climbed all over the world. He was somewhat of an inspiration to me. I got started in New Mexico, where I lived at the time, hiking up big mountains and doing some rock climbing."

Tall, snowy summits like McKinley are Vedeler's favorite.

"I've been interested primarily in alpine-type climbing," he says, explaining that he favors large, high-altitude peaks "with glaciers and that sort of thing."

Recently, though, Vedeler has been scaling the limestone cliffs of the central Texas hill country, where he and his wife, Jessica, are doing NASA-sponsored course work toward advanced degrees at the University of Texas in Austin. Jessica is an aerospace technologist in the Structural Dynamics Division at Langley.

Although she is not the avid climber her husband is, Jessica has joined Erik on a few adventures.

"We did our first big alpine climb together this summer up on Mount Rainier in Washington State. I was quite proud of her," says Vedeler. "She did quite well for a person who really doesn't have any experience."

Rainier, at 4,400 meters, is not the tallest mountain in the United States, but it's one of the toughest, he says.

"It's the most heavily glaciated peak in the lower 48 states, so despite the fact that it's only about the same elevation as the Colorado mountains, it's generally more technically demanding."

Any climb—even the simplest—is fraught with peril. One false step can mean serious injury or death. Vedeler has been lucky, although he did have a narrow escape while climbing McKinley.

"I fell about 20 or 30 feet," he recalls. "We were carrying very heavy packs on the descent, and I took a sliding fall down a slope." Fortunately he was roped up, and his climbing partners caught him.

A friend had a closer call when he fell into a snowy crevasse while scaling Mount Rainier. He might have been killed had his pack not wedged into an opening, from which he dangled, startled but unhurt, until Vedeler freed him.

"There are always these objective dangers in the sport," Vedeler says, "but if you use your head and you're careful and you know what you're doing, you can minimize those risks."

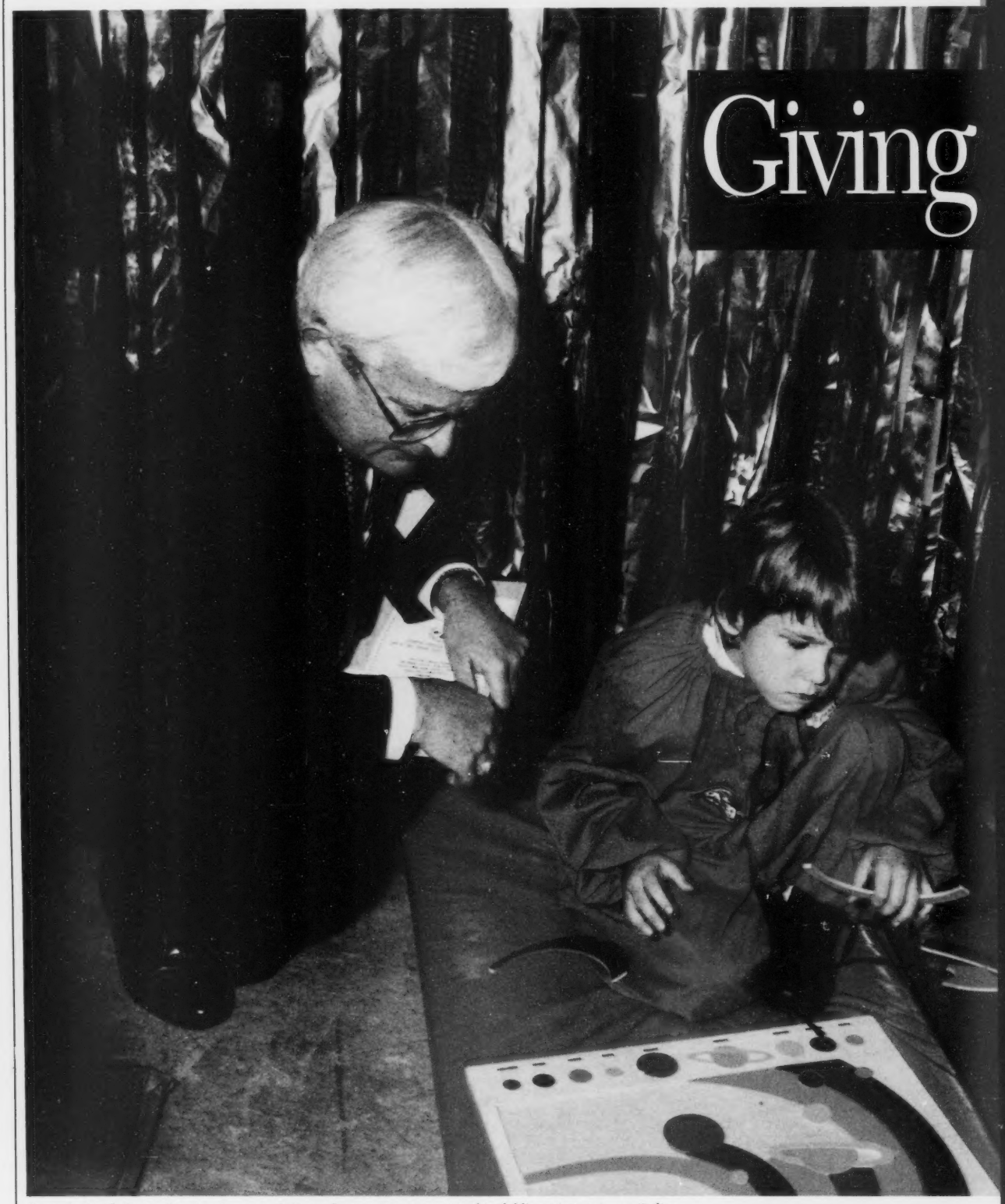
Many NASA employees have hobbies that are somehow related to their work, like aeronautical engineers who fly planes on weekends. But Vedeler says he makes no connection between mountain climbing and what he does at Langley.

It's simply a quest for adventure and beauty.

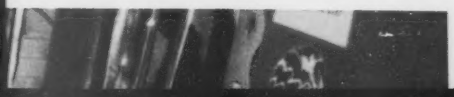
"You're up on a mountain and you're cold, you're not eating well, you're maybe not feeling 100 percent because of the altitude…but when you're up there in that high alpine environment, it's like being on another planet," Vedeler says. "In Alaska, they have something called 'alpenglow,' and it actually makes the snow and the glaciers look pink. It's just so surreal. The light, the colors, the intensities are just amazing. That's what you remember when you come back." •

Michael Finneran, who formerly worked at the Langley Research Center, wrote about windshear research at Langley in our Winter 1993 issue.

Giving



Lewis Research Center Director Lawrence J. Ross takes an active interest in this child's project at Anton Grdina.

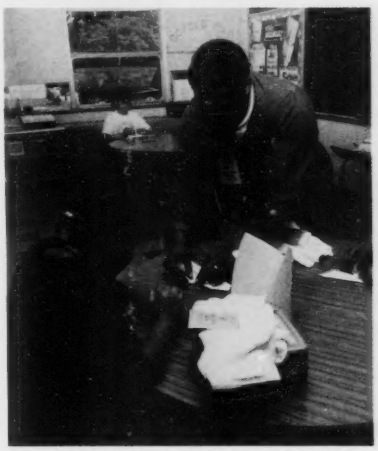


Children Space to Grow

by Michael Giannone

The astronaut pushes two buttons, a panel lights up and she is cleared to pass through the decontamination chamber. Once inside the space station, she works her way through the modules. At the Health and Fitness station, she uses exercise machines and a heart monitor to study the effects of exercise on her body. Lying on a yellow mat in the Astronomy Lab, she explores the stars and planets. In the Biology Lab, she inspects bacteria colonies growing in petri dishes and investigates the principle of buoyancy using a fish tank. Then, after a quick snack of astronaut food in the nutrition module, she monitors the space station's systems by operating educational software on the Mission Control computers.

NASA's Lewis Research Center uses the lure of outer space to help kids learn about math, science and teamwork.



Lewis's Leonard W. Cobbs, Jr., a pilot working with the Educational Resources Office, explains aerodynamics to a student.

Just another typical visit to Space Station Harmony.

This unique educational facility was designed and built by Lewis Research Center educators, technicians and engineers, working with parents and the "astronauts" themselves—about 500 preschool through third-grade students in the Anton Grdina Primary Achievement Program in Cleveland, Ohio.

The name "Harmony" reflects the spirit of cooperation that binds the kids, teachers and parents working on the project. The partnership also includes Lewis's Office of Educational Programs, the Cuyahoga Metropolitan Housing Authority (CMHA) and the Cleveland public school system. Working together, the consortium found a creative new way to use the

lure of outer space to encourage grade schoolers to take an interest in science and mathematics.

"By reaching young people in the beginning of their academic careers, we are able to teach them that the key to a rewarding educational and professional future is math and science," says Lawrence J. Ross, director of the Lewis center. Space, he says, is a good way to "sugarcoat" subjects that are sometimes seen as boring or difficult.

William R. Martoccia, who was Area Superintendent for Grdina's cluster—a group of schools located in south Cleveland—when Lewis began working with the school, says the relationship was a natural because NASA already was working with nearby East Tech High School.

"Schools for the past five or six years have been seeking cooperative arrangements with business. The [Anton Grdina] project with NASA was perfect for us."

NASA's involvement with the elementary school, located in the Garden Valley Housing Estate near downtown Cleveland, began in 1990 when representatives from the Lewis education office met with CMHA officials. CMHA was looking for a way to offer educational empowerment to people living in public housing. That objective tied into NASA's goal of capturing young people's interest in science and math and channeling that interest into related careers.

"CMHA wanted to develop a program that would provide the skills, abilities and opportunities for inner city families to succeed," says R. Lynn Bondurant, Jr., chief of Lewis's Office of Educational Programs. "Our mission was to

Anton Grdina teachers are building the Space Station Harmony *habitat.*

"My kids had no idea what was going on outside their world. They didn't know they lived on this thing called planet Earth," says Yarbrough.

provide activities to enhance the skills of educators and parents to benefit their students and their children."

A "Space Act Agreement," identifying the educational goals of the project and outlining a program of instruction, was drawn up and signed by NASA, CMHA and the Cleveland public school system.

Using another Lewis program as a reference—the Simulated Shuttle—the educational program office developed a curriculum that included lectures, a one-day "exploratorium" for parents and children, and Space Station Harmony. Lewis's Sandy Walters was assigned the responsibility of working with Anton Grdina on the project. She designed the space station and recruited the NASA volunteers who built it.

"I feel that almost everything we do in life is focused around math and science," says Walters. "They are very challenging, very creative, and you have to be somewhat dedicated to be able to absorb them."

One way to get students and their families accustomed to working in these fields is through hands-on activities. This "removes some of the doubts and fears," says Walters.

In the Anton Grdina program, students physically handle objects to gain a better understanding of mathematical and scientific principles. This not only improves their comprehension of difficult subjects, explains John M. Hairston, Jr., Director of External Programs at Lewis, it also motivates the students "to learn more, to comprehend more."

A hands-on program like NASA's also helps to focus the students' attention.

"With hands-on, there are fewer discipline problems," says Joe Ann Yarbrough, who teaches developmentally handicapped students at the school. "When a child can manipulate something rather than just sit there and be bored, there is an increased level of learning."

Before Space Station Harmony, hands-on science activities were conducted in classrooms by NASA representatives and school staff. To communicate complex, scientific theories to young children, the presenters had to be innovative.

Parents are sewing astronaut uniforms for the student-astronauts.

"I eased into it," says Leonard W. Cobbs, Jr., a pilot working with the Educational Resources Office at Lewis who used props to explain aerodynamics to the students. "I showed them a paper airplane that looked nothing like an airplane. They didn't believe it would fly. They knew there was no way it could fly. Then I flew it. They were excited. Because of that, I was able to explain the principles of flight

in a way that grabbed their imaginations."

When the NASA program was introduced, the teachers at Anton Grdina were concerned about their own comfort level with the intimidating subjects of math, science and space.

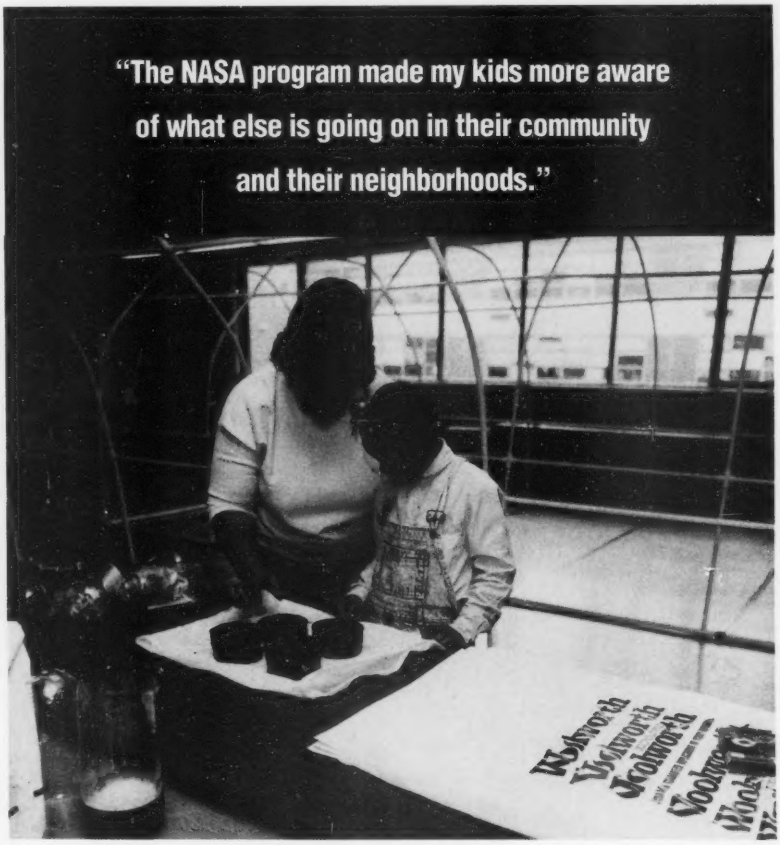
"When you're talking about aerospace and the teachers know little or nothing about the subject...yes, there was some doubt," says Walters.

To allay their concerns, instructional sessions were held for teachers, students and parents. Lewis educational specialist James Fitzgerald began making monthly visits to the school to give lectures and demonstrations on topics like Newton's laws, exercising and hygiene in space, and space suits. At the same time, Anton Grdina teachers, with the assistance of NASA personnel and others in the educational arena, began folding the aerospace theme into their classroom instruction in science and math.

"Because NASA and space are one unit, I can teach math by talking about the distance between planets. I can teach reading by reading about space," says Yarbrough.

Aside from improving basic learning skills, the program has brought NASA and space exploration to life for the students, their families and their teachers.

"My kids had no idea what was going on outside their world. They didn't know they lived on this thing called planet Earth," says Yarbrough. "The NASA program made my kids more aware of what else is going on in their community and their neighborhoods. Now when a shuttle goes up, they are aware of it. They even know who's on the shuttle."



A parent works with her child in putting together Space Station Harmony.

Eventually, the aerospace "theme" extended beyond the original focus on math and science. Like other interdisciplinary themes, it is now used across the entire curriculum, from health to social studies to music and physical education. Students in creative writing courses write about space and NASA in their daily journals. In art class, they create astronauts, rockets and planets using paper and crayons. To build the students' vocabulary, teachers even use an aerospace Word-For-The-Day. A template designed to look like an astronaut hangs in the hall so the children can see it as they enter school in the morning. Each day words like "ROCKET BOOSTER," "NEWTON'S LAW," "SPACE STATION" and "BACTERIA" are posted on the astronaut.

"A committee of teachers selects words based on what's going on at NASA," explains Yarbrough. "They then go to each classroom and pick a child. Prizes are given to students who know the word, can define it, and can use it in a sentence."

At the end of each day, the word is added to a vocabulary list that lines the hall. Other aerospace images adorn the school's classrooms and library, and nearly every room has a rocket, shuttle or astronaut.

With enthusiasm running high in the daily classroom setting, program organizers decided to try something different in the spring of 1991 by holding the first ever "exploratorium" in the Cleveland City School District. For this day-long science event, classrooms were converted into stations for hands-on science activities, each lasting 35 to 40 minutes. The lessons were taught by NASA engineers, Cleveland public school science teachers, teachers from Anton Grdina's staff, instructors from Case Western Reserve University, members of Cleveland's Inner Church Council and representatives from private industry.

Students and adults both were welcome. "We used the students as our 'marketing tool,'" says Walters. The price of admission for each child was to bring an adult along. "We knew if we got the little ones hyped up about coming, they were going to pull Mom, Dad, aunt, uncle, somebody, anybody out of the house to participate," she says.

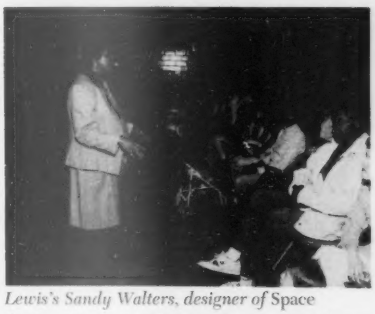
In fact, one of the program's goals is to increase parents' involvement in their children's education by teaching the adults about math and science, too.

"[The parents] were provided with their own classes for learning about aerospace and health," says Anton Grdina's Principal, Inez Powell. "Whenever we had instructional sessions for the staff and the students, we would also plan a time when the parents could get the same type of information."

That way, she says, the adults learned "not necessarily because of the children, but because they wanted to."

On June 3, 1992, NASA's involvement with Anton Grdina reached a climax with the launch of Space Station Harmony. The big event included a simulated countdown, liftoff and docking of the shuttle with the space station—all with children at the controls. At each work station, the students also conducted basic science experiments, which they explained to visitors, students and parents.

The following October, NASA Administrator Dan Goldin, astronaut Charles Bolden and Ohio Congressman Louis Stokes paid a visit to Anton Grdina and toured Space Station Harmony. Again the student-astronauts operated the station and showed off their newfound knowledge. Although that was a one-day event arranged especially for the Goldin visit, Space Station Harmony became an official part of Anton Grdina's curriculum in January of this year. Students now use the facility as part of their regular science instruction, making weekly visits to the space station.



Lewis's Sandy Walters, designer of Space Station Harmony, *takes part in providing classes for parents of Anton Grdina students to learn about aerospace and health.*

As a spinoff of the NASA program at Anton Grdina, parents continue to receive education as well. Black Data Processing Associates (BDPA), a non-profit, professional minority organization that supplied computers and instruction for the space station, offers parents free classes in how to use a computer. In addition, representatives from BDPA visit the school for one hour each week to teach children personal values like pride, self-esteem and trust.

"Kids seldom see successful, professional African-Americans," says Norman Mays, a BDPA representative. By providing young people with role models, he says, "We can plant the seed and plant the images through our behavior."

NASA's involvement with Anton Grdina gave the school more than a theme for education. It also enhanced cooperation among the staff.

"It turned out that the program did much more than we ever expected," says Powell, by strengthening the teamwork that already existed among teachers through the school's participation in Cleveland's Primary Achievement program. Anton Grdina was one of two pilot schools for the program, which began in 1989 and now involves 12 of the city's 80 elementary schools. In Primary Achievement, students are not graded. They move through the school at their own pace, based on their ability to master a set of identifiable skills. Students in second grade may return to first grade for part of the day to work on a skill not yet mastered, or a first grade student who has already learned certain skills may spend time with a second grade teacher.

"Primary achievement requires a change in teaching style," says Pamela Hummer, a preschool teacher at Anton Grdina. "You can't close the door and do your own thing. You have to relate with your colleagues. Primary achievement forces you to be more responsive to the individual needs of the child."

Hummer says that it has been hard to separate her experience with

Goldin and Anton Grdina principal, Inez Powell, view a student-astronaut's slide presentation.

Primary Achievement from her experience with NASA.

"What may have contributed to both programs being successful is that we had a staff that was willing to try something new. We knew things weren't working the way we've been doing them for years."

The focus on the student's individual needs has produced positive results. The Primary Achievement Program coupled with NASA's emphasis on science and math has pushed up Anton Grdina students' scores on standardized testing.

"Scores went up significantly in the 1991-92 school year," says Powell. "In each grade level, vocabulary comprehension and math scores went up. In many instances we surpassed our cluster and the district."

Real success, of course, will take years to determine. Not until students move through the educational system will there be enough data to fully assess the program's value. While Lewis's Bondurant believes it will take at least one generation to see if Primary Achievement and the NASA program are truly successful, he would like to see the space agency increase its involvement with primary education.

"If there is a weakness in NASA's educational program, it's that we don't do enough with the primary grades," Bondurant says. "We do a lot at more advanced levels, but we need to get students excited about math and science early on."

John Hairston agrees, and would like to see Lewis's involvement extend through the entire educational process.

"If we can bridge the gap between upper elementary schools and high school...and provide a vehicle for the underserved population in our public schools to become involved in NASA and in math and science, Lewis may be able to produce a model program for the agency—while at the same time meeting our national need for more engineers and scientists," he says.

"I look at Anton as the beginning of the pipeline," says Walters. "I hope, somewhere down the line, the students will be able to say, 'One of the reasons I'm an engineer is because of the program at Anton Grdina.' I would love to see an astronaut or several astronauts come out of the school. I would love to see some of those kids working out here at Lewis."

Lewis's Cobbs also hopes the program will turn out NASA employees. But he sees value in producing an educated public, as well.

"We all still benefit. They don't even have to be engineers. They just need to know enough to make an informed decision," he says.

The mission patch for Space Station Harmony, like its name, was decided by a contest among the students. The winning patch, designed by second-level student Wilbon Anderson, bears an image of the shuttle taking off. Next to the shuttle, an astronaut stands beside a flag firmly planted on the Earth. On the flag are butterflies, the school's mascot.

The butterfly was chosen as a mascot when Anton Grdina became a Primary Achievement program, around the same time Lewis became involved with the school. The butterfly symbolizes the goal that teachers, staff and NASA have for the students: that they be able to soar as high as they can after emerging from the restraints and limits of the cocoon. •

Michael Giannone is a writer/editor with the Editorial Branch at the Lewis Research Center.

Five-Part Harmony

From countdown to lift-off, the launch of Space Station Harmony united the talents and interests of five distinct groups— parents, teachers, the community, students and NASA— to achieve a single goal — to build a habitat that will excite children about math and science. Over a five-month period in the winter and spring of 1992, the station evolved from a rough sketch to an actual learning center that is turning students into eager young scientists.

Operating with a $1,500 budget supplied by the Cuyahoga Metropolitan Housing Authority, engineers and technicians from Lewis, working closely with an enthused group of some 75 parents, students and teachers, were able to complete the Space Station Harmony shell for a quarter of that.

Built in a 12- by 18-meter room at the Anton Grdina school, the space station habitat is actually two, side-by-side, 2.4- by 3 meter modules. The shell of the station is made of more than 300 meters of PVC pipe and about 100 different T and elbow joints, sleeves and adapters, all wrapped in cheesecloth.

Space Station Harmony *mission patch designed by student, Wilbon Anderson.*

Teachers and students hung educational charts, plants and colorful streamers in the modules to make each station an individual science lab. A tunnel leading into the station was lined with aluminum foil, creating a science fiction-like decontamination chamber. A detached module with computers serves as mission control.

Space Station Harmony evolved from a sketch by Sandy M. Walters of Lewis's Office of Educational Programs. Benjamin Solis of the center's engineering directorate then used her design to develop the habitat, basing the structure on a tent he had constructed out of tubing for his children.

"I took the sketch and then came up with a concept," says Solis. "From there I went to a better fidelity sketch. It wasn't really an engineering drawing. It was just something better to build off of."

Assembling the space station called for more volunteers. Lewis personnel, which included Walters, Solis, Jose A. Ayala, Thomas W. Balogas, Anderson K. Marlow, Jr., Robert A. Paulin, and Carmela Bynum, worked with parents and students on the construction.

"I thought it was great that an inner-city school could be involved like that, to have a habitat in the school," says Bynum. "Those kids really got into it. You could just feel it. They were really excited about the whole thing."

For many of the students and parents, the excitement of building the station did not end with its launch. The children continue to be excited about the project.

"The kids talk about it a lot," says Sharon Owens, a parent-volunteer whose son, Randy, is a second-level student at Grdina. "My son, that's all he talks about. My niece, too. They get paper at home and try to figure out how they can make (a space station) at home."

The ongoing enthusiasm of the students best sums up the project at Anton Grdina. If that excitement remains with the children throughout their education, perhaps it will also follow them into their careers— careers that could bring them to NASA. •

–Michael Giannone

Principal Inez Powell and a student busily outfitting Space Station Harmony.

Antarctic Adventure

Exploration has its risks, as Ames researcher Dale Andersen found out for himself on a recent trip to the far south.

The Fedorov carried the researchers to Antarctica.

by Linda Billings

Scientists know all about the dangers of Antarctica—they've been working there for decades. And exobiologist Dale Andersen, a veteran of several Antarctic research expeditions sponsored by NASA and the National Science Foundation, certainly knows his way around The Ice. But on a recent trip, a simple data-gathering exercise turned life-threatening in the blink of an eye.

Andersen traveled to Antarctica in November 1991 on an exobiology research expedition to Russia's Bunger Hills station. A cooperative effort between NASA and the Russian research establishment, the expedition included eight Russians, two Americans, and one Canadian who came to the harsh polar environment to learn more about the outer limits at which life can survive. Exobiologists apply these Antarctic

studies to the search for signs of past, or even present, life on Mars.

Bunger Hills is a very isolated spot, halfway around the continent from the large U.S. research base at McMurdo Station. It hadn't been used for more than a year before the team arrived to find that part of the station had been destroyed by winds. It was still liveable, but it was even more spartan than usual, by Antarctic standards.

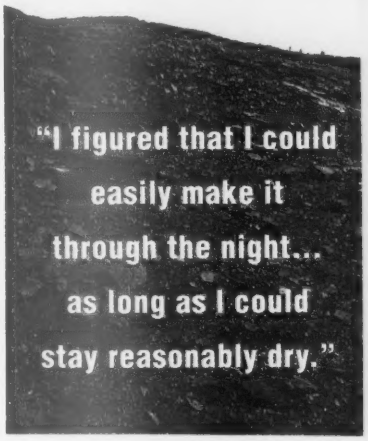
From this remote position, communications were no easy matter. The Russian team members had to radio and telegraph messages to another Russian station 800 kilometers away, which would then forward them to Moscow. The Americans brought with them a new portable communications system provided by the NASA Science Internet. It included a transceiver the size of a shoebox and a football-sized antenna, interfaced with a computer run by solar-power-charged batteries. With this system, the team could send and receive electronic messages via an Inmarsat satellite.

On March 19, 1992, Andersen, Peter Doran and three other colleagues set off in separate directions from Bunger Hills to conduct synchronized measurements of tidal flows at five different spots a few kilometers apart. Andersen and Doran were traveling the farthest, which meant that they had to spend the night at an "ice camp" on the edge of a lake about 12 kilometers from the main camp, Oasis Station. From there they planned to split up the following morning, collect their data and rendezvous back at the ice camp.

But as Doran later wrote in an electronic mail message to colleagues in the States, what was supposed to have been a routine trip turned into "a nightmare."

The weather had been beautiful when the team left the main camp. The first night Doran and Andersen spent at ice camp, the winds picked up, and by the time they woke at 6 a.m. to start their measurements, the winds were "heavy but not unworkable."

But as the day went on, "it got worse," Doran wrote. "Much worse." He returned to ice camp at 5 p.m. and found it empty. After spending the next three hours trying, without success, to contact the main camp by radio, he decided to stay the night and head back to main camp in the morning.



That trek "was the most horrendous trip of my life," Doran wrote. What should have been a two-and-a-half hour walk turned into six hours of torture over the rocks and ice. But he made it. When he arrived back at main camp, he found the other three researchers had returned safely, but not Andersen. What none of them knew was that their friend was engaged in a life-or-death struggle alone on the ice.

Andersen recounted the story in his own E-mail message to the States on March 22: "The last several days have been somewhat of an adventure —one that I hope will not be repeated."

As Andersen told it, the wind had begun to kick up from the east the morning he and Doran awoke in ice camp. It was nothing unusual, though, and they decided to go ahead with the planned work. Andersen threw on his pack, put on a couple of crampons—spiked iron plates that fit on shoes to prevent slipping on ice or snow—grabbed his ice-axe and headed up the glacier to a small lake resting in a depression surrounded by ice on three sides and rock on the other. As he walked down into the basin, the winds began to increase but were still "no problem."

He set up his instruments and went to work. "The winds continued to pick up all day," he wrote, "but I needed to get the tidal turnover, which would not occur until after 3 p.m., so I was determined to stay at least until then." At 4:45 he still had not seen the tide begin to drop, and by this time he was becoming concerned about making it back to camp. The wind had already started tossing him around, and it was getting much worse.

He packed up everything and started up the side of the glacier from the lake, but the winds had become very violent and were blowing down one side and back up the other. "The downdrafts were absolutely incredible," he wrote. "I have never been hit by such an enormous force. Each time I tried to leave, the wind would blow me back down, slamming me into the ice and carrying me about 20-30 meters over the ice like a rag doll"—even though he was trying to stop himself with

his ice axe.

As snow began to blow and the visibility dropped, Andersen now realized that his situation had grown very serious. After trying to climb out five or six more times in zero visibility weather with no success, he decided the prudent thing to do was to stay the night. Accommodations consisted of rocks, and he was concerned about being out of contact with his colleagues. Although he had a walkie talkie in his pack, someone had borrowed the others before the researchers left. Even if they did have a walkie talkie, he doubted they would be able to hear him over the howling wind. His major concern, he wrote later, was that, "I did not want them to risk their necks trying to find me."

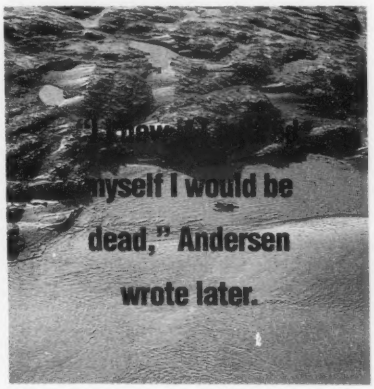
He made a stone wall for protection from the snow and wind. Fortunately, he had along a tent called a "bivy sac" and a sleeping bag with some food. He removed his boots and outer garments, which had become completely covered in ice, placed them in his pack, then jumped into his sleeping bag and zipped the bivy sac shut.

"All night I was pounded by these horrendous downdrafts," Andersen wrote. "Although I was somewhat cold and clammy, I was nevertheless OK, and I figured that I could easily make it through the night…as long as I could stay reasonably dry." Fortunately, the bivy sac was made of Gortex, which kept out most of the water.

After a long sleepless night, the morning arrived with no lessening of the wind and snow. Visibility was only a few feet. At 9 a.m., Andersen decided that he had to get off the glacier. The sleeping bag was becoming soggy, and his clothing was losing its usefulness as an insulator. He also was still worried that his colleagues might try to look for him. One stranded scientist was enough.

Aerial view of the main camp at Bunger Hills.

His first attempts at climbing the side of the glacier "resulted in my body getting slam-dunked against the ice, again and again." At one point he thought that he would actually be carried over the lake ice and up the other side of the glacier.



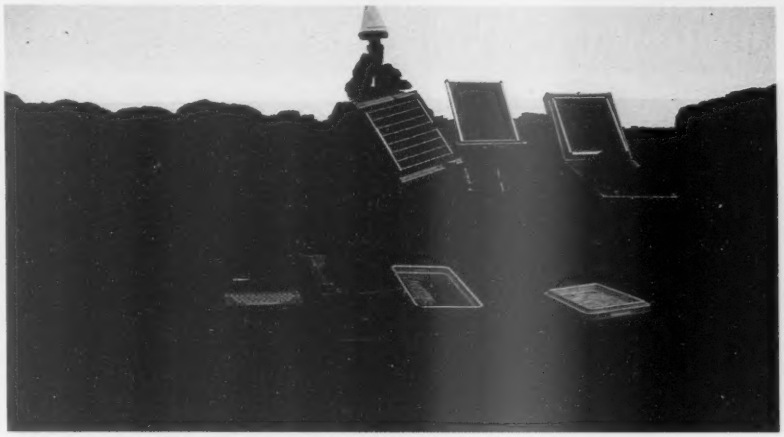
Finally, though, the winds died down enough for him to make it out.

At first, he was "filled with joy" that he had finally escaped from his hole, but the happiness soon disappeared as the wind redoubled its efforts. "I was carried another 30 meters or so across the ice (believe me, it hurts like hell to be dragged across rough ice) for what must have been the 30th time by now."

Finally, he anchored himself with his ice axe and remained pinned to the ice for almost half an hour. As he lay there, he lectured himself on the importance of moving with as much caution as possible. "I knew if I injured myself I would be dead," he wrote later.

When he tried standing up again, the wind immediately slammed him down, giving him a bloody nose, a chipped tooth, and two cuts along with a lump on his forehead. For all his trouble, he had managed to advance only a few feet. And the ice camp where he and Doran had stayed two nights earlier was still a few kilometers away.

Finally, though, he was able to make some progress. The camp lay to the northwest, but walking with the wind was impossible, so Andersen could only walk northeast, into the wind. After five hours of struggle, he made it off the glacier and onto solid ground. Because he had not been able to light his stove he hadn't eaten much, so as he



The communications setup in the Antarctic looks as awesome as the terrain.

rested in the protection of a large boulder he ate a little jam and snow.

Andersen made it back to the ice camp about 4 p.m., "just in time for the radio check." The team's practice was to check by radio every hour on the hour to try and reach people who were out of contact.

At camp, one tent had been blown down and torn up, but another was still in good shape. Andersen set up his radio and heard his colleagues broadcasting a message to him, including the good news that Doran had made it safely back to the station. Unfortunately, the radio batteries were so low and communications so bad that [the team] could not hear his reply (later it turned out that one scientist had heard Andersen calling, but decided he was imagining things in the din of the storm).

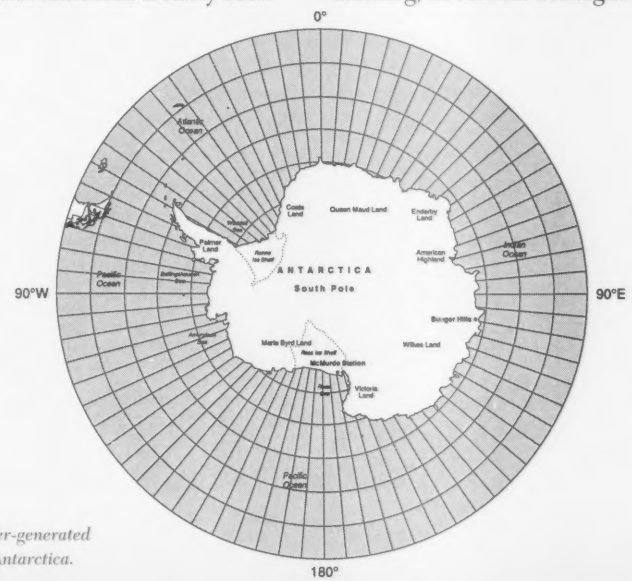
At 5 p.m., Andersen finally got through to the team and told them he was all right. The next radio check would be at 10 the next morning. He spent the night in a dry sleeping bag in the one remaining tent. In the morning, he told his colleagues that he would set off for Oasis Station at 1 p.m. They advised him to take the long way around Lake Figourney because wind had stripped away its ice cover, making it unsafe for walking. The detour turned a three-hour walk into a six- to seven-hour fight against the wind.

He did make it back in one piece, though, much to his colleagues' relief. The next morning, Andersen found out that while he was stranded on the glacier, one of his colleagues at the station had watched an anemometer hit 46 meters per second—about 100 miles per hour—before the wind blew it off its pole.

"It was certainly an excellent lesson in the dangers of this place," Doran commented later in his message from The Ice. "It's a real good sign that Momma Antarctica has given up enough secrets and wants us to get the hell out of town."

As for Andersen, he wrote to his colleagues back home that, "In addition to the bumps and bruises I received from the glacier, I learned a little more about human nature and a bit more about myself…plus we did get some reasonable data…all in all a positive experience, but once is enough."

Andersen returned to California late in the spring of 1992 after more than four months on The Ice and two months at sea traveling around the continent. But in October he was back again, under the auspices of the NASA/NSF Antarctic Space Analog Program, for another three months of research in the McMurdo Dry Valleys. •



Computer-generated map of Antarctica.

Linda Billings is a senior writer for BDM International, who wrote about engineers in JPL's Digital Projects Group in the Winter 1993 issue of the magazine. Photos, courtesy of Dale Andersen.

Live From the Bottom of the World

Antarctica, December 1, 1992 — Standing on an ice-covered bluff in Antarctica, NASA Science Internet (NSI) engineering manager Mark Leon and NASA researcher Carol Stoker wait patiently, if coldly, as technicians scramble to complete a satellite linkup with the Ames Research Center. Also standing by are Ames scientist Dale Andersen and David Bresnahan, the National Science Foundation's senior representative at McMurdo Station. In a few minutes, the first-ever live televised news conference from Antarctica is about to begin.

Mark Leon positions the camera to pull off the first-ever televised news conference from Antarctica.

To arrive at this moment, Leon and his team have put in many long hours and spent many sleepless nights on The Ice. From the moment they arrived on the frozen tundra they have been confronted with unpredictable problems, most of them due to the harsh Antarctic environment.

"Cables would melt into the ice, then become frozen over," Leon recalls. Lasers had to be stabilized to transmit the signal. And as if that weren't bad enough, there was the constant frustration of working with what Leon calls "World War II-vintage equipment."

The show did go on, however. ABC-TV was able to broadcast its entire "Nightline" program from Antarctica on November 24, and "Good Morning America" aired a live broadcast the following morning.

Behind the scenes, though, it was anything but routine. "We were forced to use paper clips and alligator clips for the connections to allow the ABC broadcast," Leon says. "No one at ABC ever knew the difference; I didn't tell them until the event was over."

After the ABC broadcasts went so well, Leon's team decided to try a live news conference. The complexity of the engineering challenge meant that Leon had to work around the clock. "Nineteen to 22-hour days were normal," he says.

Because meals were served only at specific times in the McMurdo cafeteria, Leon often missed them, and he relied on the kindness of others to bring him something to eat.

"I lost 10 pounds from missing meals while I was there," he says. He also suffered minor frostbite on his left thumb and right index finger during the two weeks he spent on The Ice.

After all the hard work, the historic news conference finally got underway on December 1. Wearing bright red parkas with the frozen tundra providing a scenic backdrop, the NASA researchers deftly fielded questions from news reporters gathered in a warm auditorium back at Ames.

The scientists talked about their work exploring the physical and biological characteristics of Lake Hoare in McMurdo's Dry Valleys—research that provides insights into what kinds of life may once have existed on Mars. They also discussed the advanced "Telepresence-controlled Remotely Operated Vehicle" (TROV) used for these studies. While the TROV—a remotely controlled mini-submarine equipped with a video camera—explored the lake floor, researchers wearing video headsets on the surface would point the TROV's cameras by moving their own heads and would "drive" the vehicle with joysticks. Scientists hope eventually to use TROVs to explore these frozen lakes remotely from the Ames center in California.

One reporter asked the researchers to describe a typical day in Antarctica. Although on this particular day the temperature was balmy by Antarctic standards—25 degrees—it can get a lot colder, especially during the winter months. Bresnahan said the fact that it never gets dark during the summer months can be confusing, causing people to lose track of what day it is and to work long hours due to the constant sunshine.

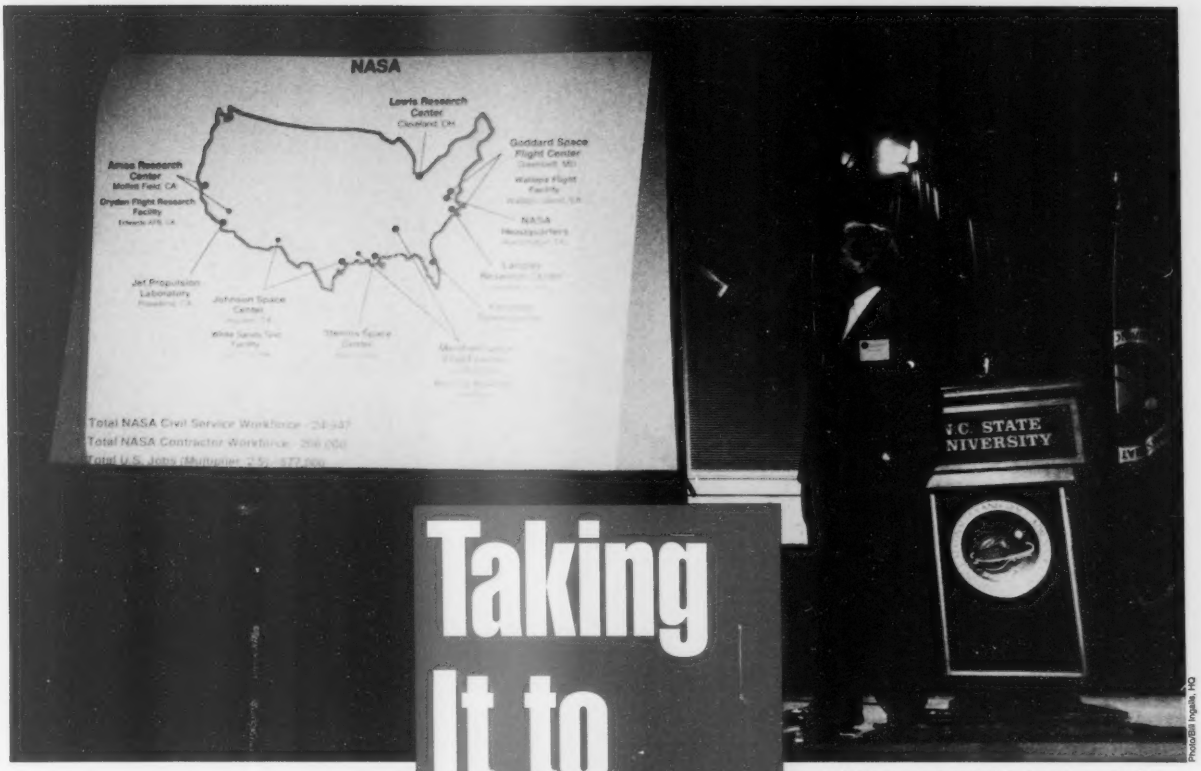
By the end, the Antarctic press conference seemed as smooth as if it happened all the time. The televised images and sound quality were sharp and clear, despite the two-and-a-half-second delay between questions and answers.

Leon says that he's proud of his crew's part in pulling off a technical first. "This was an incredible team effort between Ames, Marshall, the National Science Foundation and Antarctic Support Associates (ASA)," he says. "Without their assistance, I could never have pulled it off."

At the same time, he admits that even though Antarctica is a beautiful place, "I have no desire to return." •

–Michael Mewhinney and Donald James, ARC

NASA scientists testing a Telepresence-Controlled Remotely Operated Vehicle (TROV) underwater in preparation for last October's two-month long expedition to Antarctica.



Administrator Dan Goldin introduces NASA to the audience at the Raleigh Town Meeting last fall.

Taking It to the Streets

At a series of town meetings held around the country last fall, NASA talked face-to-face with its "customers."

by Linda Billings

What do the American people think of the nation's aerospace program? Some say the high level of public enthusiasm for space exploration during the Apollo era was a byproduct of political tensions that no longer exist. Others argue that the country still takes pride in its aerospace program as a symbol of leadership and technological excellence.

Last fall, NASA tried to find an answer to the question by holding a series of town meetings across the country.

"We view the town meetings as a crucial step in exposing the general public to the new NASA that is emerging from our internal reviews," said NASA Administrator Dan Goldin in his open letter of invitation to the public. "Specifically, we hope to get your reaction to a more detailed version of the [NASA employees'] 'Vision Statement' now under development, and on the proposals generated by the review teams as we prepare to take the next step—the writing of a new long-term strategic plan to fulfill that vision."

The meetings were held in six different locations where NASA does not have a major presence: North Carolina State University in Raleigh, on November 9; the University of Hartford in Hartford, Connecticut, on November 17; Indiana University-Purdue University in Indianapolis on November 20; California State University-Dominguez Hills in Carson, on December 3; the Univer-

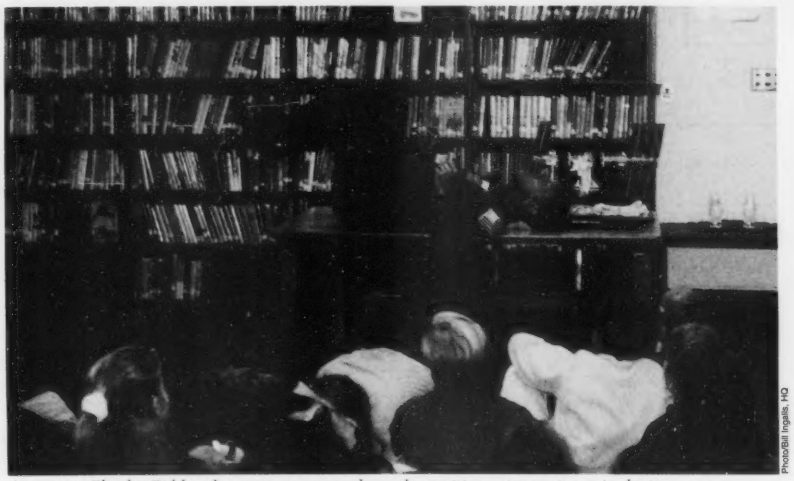
sity of South Florida in Tampa on December 11; and the University of Washington in Seattle on December 16.

Local and national organizations helped NASA publicize the meetings, lending mailing lists, making phone calls and contacting local media. The agency made a special effort to invite small and disadvantaged businesses and minorities, and received help from the American Institute for Aeronautics and Astronautics, the National Space Society, The Planetary Society, the Research Triangle Institute, local Chambers of Commerce, the hosting universities and the National Association for the Advancement of Colored People. More than 100,000 invitations went out in the mail for all six meetings combined.

The response was well worth the effort: More than 4,000 people attended the six town meetings. Another 500 individuals took the time to put their comments into writing, including whole classes of students. And thanks to wide-ranging media coverage, the meetings reached far more than the 4,000 people who attended.

Daily newspapers ran stories ("NASA chief wants his agency to fly high on risks and dreams," read one headline), network and cable television stations gave the meetings air time, and NASA Select TV provided live coverage. In addition, NASA's LASER Van (a mobile teacher resource center) and Space Station Freedom exhibit toured the cities that hosted the meetings.

Aside from participating in the town meetings, Administrator Goldin and astronaut Charles Bolden (accompanied by astronaut Franklin Chang-Diaz in Los Angeles) visited local elementary and secondary schools, addressing assemblies of 300 to 700 students at each one. The NASA contingent also toured local research facilities and conferred with university and business officials. (For the school visits, the agency targeted culturally and economically diverse student bodies. For meetings with business officials, NASA focused on small and disadvantaged companies.)



Photo/Bill Ingalls, HQ

Astronaut Charles Bolden demonstrates to students the position astronauts are in during Space Shuttle liftoff.

"As explorers, pioneers, and innovators, we will boldly expand the frontiers of air and space for the benefit of all."

NASA Vision Statement, November 1992

From the first gathering in Raleigh to the last one in Seattle, the size of the crowds and their level of interest and enthusiasm were impressive. "I've been a taxpayer for thirty years," said a man from Meriden, Connecticut, "and this was the first time any government agency ever came to me to ask for my opinion on how that money should be spent. I appreciate it."

The participants cut across boundaries of age, gender, profession and interests. About half were corporate or professional representatives. Another 12 percent were university students, teachers and researchers, and a surprising 38 percent identified themselves simply as interested citizens. A few were aerospace celebrities: Apollo astronaut Buzz Aldrin showed up at the Hartford meeting, and Russian Space Agency head Yuri Koptev gave an impromptu speech at Carson.

The people who spoke out at these gatherings offered praise as well as criticism. Most were unabashedly enthusiastic in their support for the aerospace program, and their interests ranged across all of NASA's activities. Some, however, were critical of aerospace spending in these fiscal hard times, and even enthusiasts were not always happy with NASA's current state of affairs.

At each town meeting, Administrator Goldin explained the purpose of the gatherings, the state of the

agency and NASA's plans for the future. "Where should we go?" he asked. "What should we do? How can we be sure we spend taxpayers' money not only effectively but with a maximum benefit for the country?"

Along with Goldin, a panel of NASA experts—Associate Administrators and other high-level officials—fielded questions and comments from the audience under the expert guidance of Bolden, who led NASA's Red-Team/Blue-Team internal review exercise.

Members of the audience peppered the NASA team with challenging and often provocative questions: Why did NASA abandon the Saturn 5 launch vehicle, and can we revive the program? Will NASA use the Russian Energia launcher and the Russian space station Mir? Is the Space Shuttle adequate to support the construction and operation of Space Station Freedom? What can NASA do to protect the environment? How can the agency seek funds for new programs when people are hungry and homeless? What can NASA do to stem the loss of technological expertise in the form of thousands of unemployed aerospace scientists and engineers?

The two messages conveyed most loudly and frequently were that NASA needs to do a better job of communicating with the public, and that it should invest more in developing educational tools. People of all ages and walks of life said they were interested in learning more about NASA's activities, but did not know how to get the information.

"It is imperative that NASA get closer to the public," said one woman from Indianapolis. "NASA is no longer a household word." Teachers, parents and students asked for more aerospace-related educational materials and more NASA representatives to spend time in classrooms.

Critics of aerospace spending didn't mince their words. "While it may be true that a few interesting developments have come from the space program," said a man from Daytona Beach, "for the most part it has been an incredible waste....With the budget in the mess that it is, the space program should be suspended entirely for at least ten years."

Photos/Bill Ingalls, HQ

A NASA proponent who drove over two hours to attend the Raleigh town meeting, shows the audience his "GO NASA" license plate.

A man from Sarasota offered a similar opinion: "As long as there are so many Americans who can't afford health insurance, who don't have a home, who don't have sufficient to eat, I think sinking money in NASA is a crime against the nation."

But the critics were vastly outnumbered by the advocates. "We don't want any of these programs cut," wrote a woman from Daytona Beach. "Go for it! Wish you all the luck in the world."

A woman from Rocky Hill, Connecticut, advised that "The spirit and imagination of the American people can be NASA's greatest political ally, now and in the years to come." And a man from Indianapolis said, "We can make it. Our future is at stake."

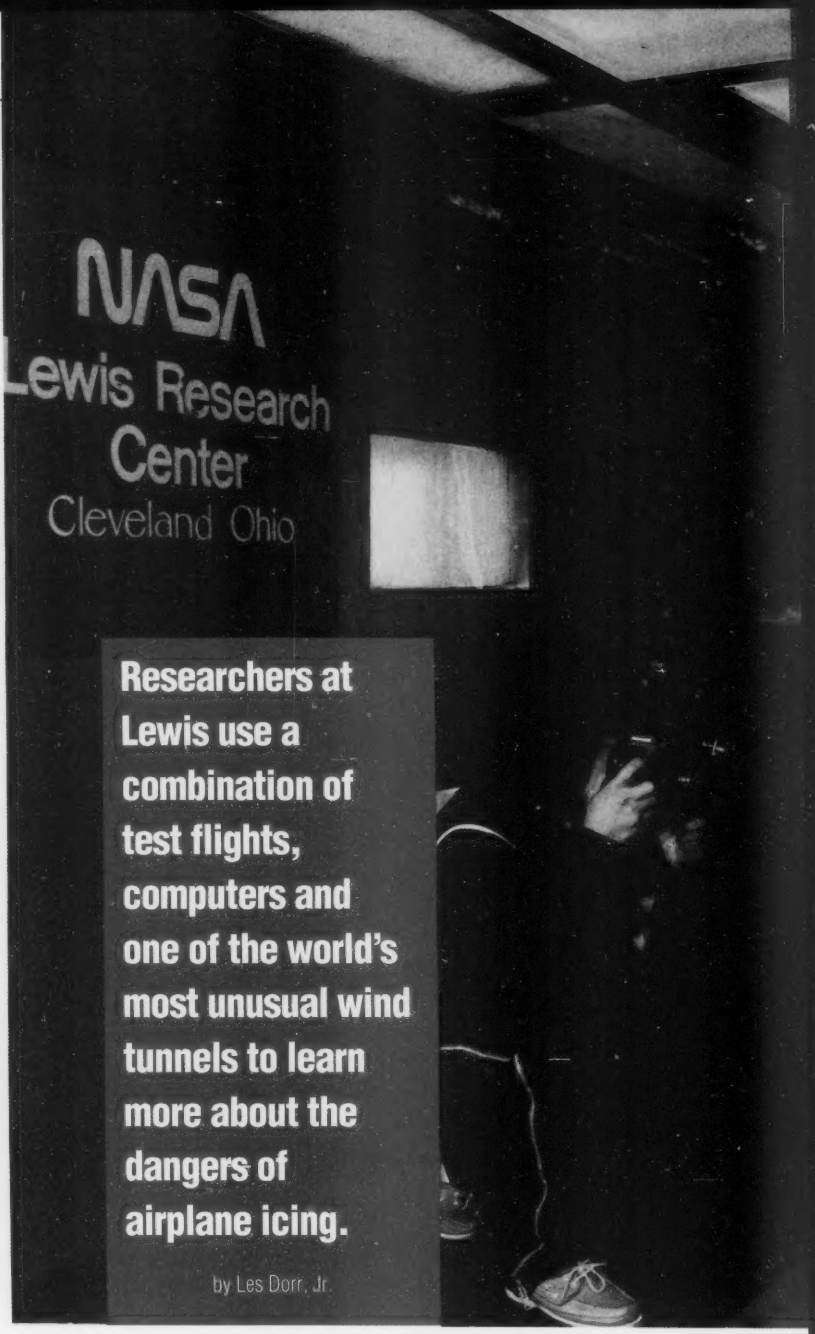
The senior citizens who attended the meetings showed that they care about NASA's future, some with a passion. "I am a 72-year-old frustrated spacefarer who never had the opportunity to participate hands-on in this greatest venture of all time," wrote a man from Silverdale, Washington. "At age ten, I was caught up in the excitement and the vision of things to come, but due to the Great Depression, was not able to find the path to the dream....[Today] space is the only thing that remains for us to embrace, and being so vast, we can beat upon its shores for centuries and never scratch the surface."

At every town meeting there were always more people wanting to speak than there was time to hear them, and the desire for information, answers—and action—was overwhelming. In a sense, the meetings were a kind of nationwide brainstorming session on the nation's future in aeronautics and space. The people who participated made it clear that they are NASA's "customers," and many urged NASA to keep the dialogue going. Clearly the town meetings—the first in NASA's history—surpassed the agency's original goals and objectives. Perhaps they will mark the beginning of a continuing effort to stay in touch with the public who pays the bills.

We Freeze

Researchers at Lewis use a combination of test flights, computers and one of the world's most unusual wind tunnels to learn more about the dangers of airplane icing.

by Les Dorr, Jr.



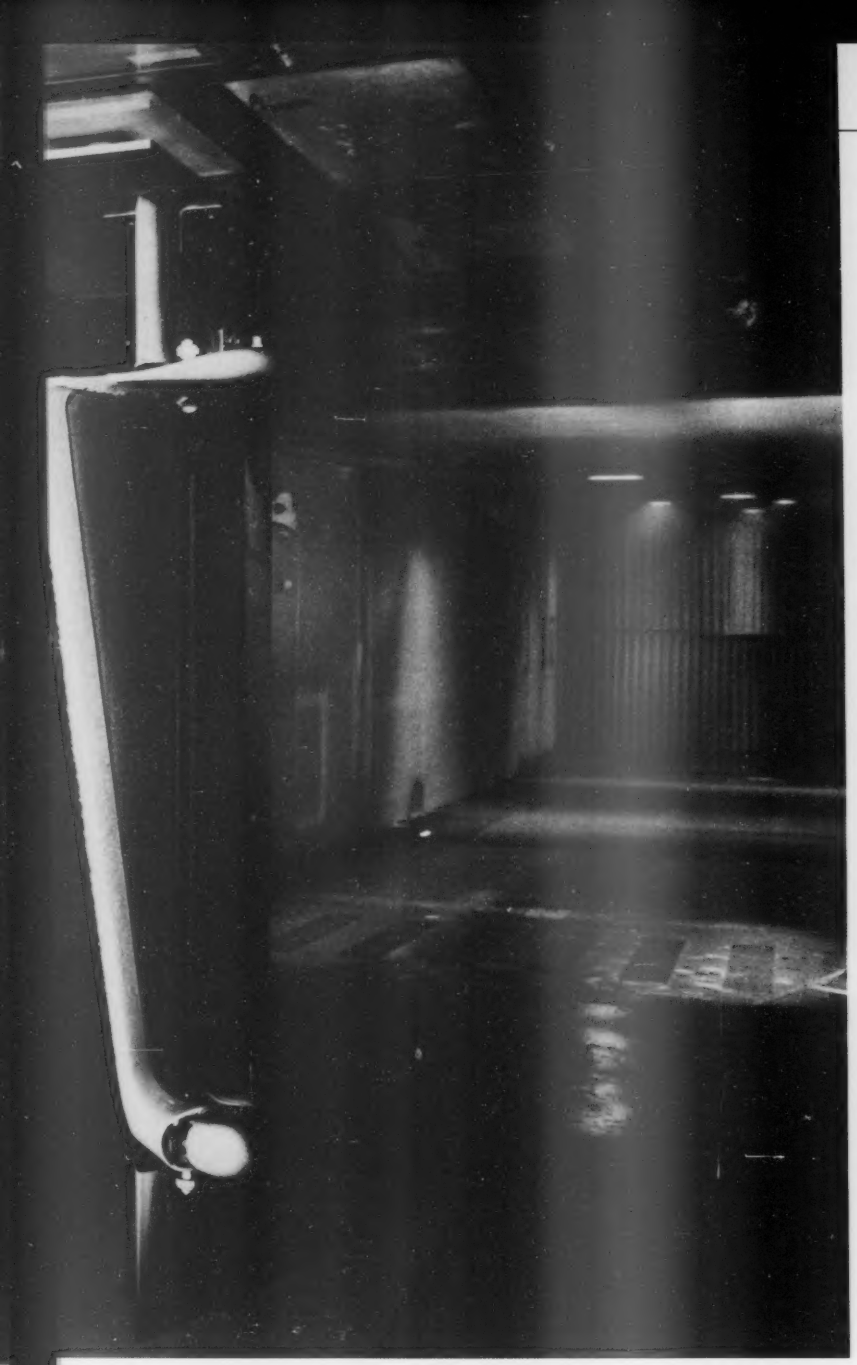
An airliner slides off the runway while taking off during a winter storm. Soon the phone rings in Jack Reinmann's office at the Lewis Research Center in Cleveland. A reporter wants to know: Could ice on the plane's wings have caused the accident?

Unless a plane goes down and ice is suspected as the culprit, the media rarely bother Reinmann and the rest of Lewis' aircraft icing researchers. Their work is wide-ranging, but low-profile: Scientists churning out computer models of ice buildup; technicians freezing airplane models in a wind tunnel; pilots flying an old twin-engine turboprop through ice clouds. Not exactly the stuff of which banner headlines are made—but absolutely vital.

"Every aircraft that flies is likely to encounter icing sometime," says Reinmann, chief of Lewis' Icing and Cryogenic Technology Branch. "It's a problem that never goes away. It has to be revisited every time there's a new aircraft design, new technology or new mission requirements."

Icing research is fairly new to NASA. The space agency's predecessor, the National Advisory Committee for Aeronautics (NACA), once had the world's best reputation in the field, but by 1955 its efforts had tailed off. NASA itself did only limited work until 1978, when it created a formal program at the urging of icing experts in the United States and Europe.

There were several reasons for the revival of interest in icing. Modern airliners just coming into service around the late 1970s depended on carefully shaped airfoils



to meet their range and weight-carrying goals. Ice buildup—something no one really knew how to predict—could affect their aerodynamic performance. Also, the planes' fuel-efficient engines were limited in their ability to bleed off hot air for thermal ice protection systems.

Military aircraft designers faced their own challenges. Engineers didn't want to add the weight of anti-icing devices to high-performance jets, so they needed to know where ice would build up and how it would affect a plane's performance.

NASA's icing research is like a tripod made of three "legs": computer simulations, tests in ground facilities and flight experiments. All three legs are necessary to stand. Computer models are verified by wind tunnel tests on the ground. The accuracy of tunnel runs depends on information collected under actual conditions during research flights. And computers are used to create artificial ice "shapes" that are tested in flight to assess their impact on aircraft stability and control.

"There's an infinity of icing conditions that you have to deal with, so researching them in flight would take forever and the cost would be prohibitive," says Reinmann. "You take advantage of computers to find the critical conditions and their associated ice shapes and then use your other facilities to test them."

Coming up with reliable computer models of what happens when an aircraft confronts icing is a prime goal of the NASA researchers. Reinmann and his crew started with existing air flow codes, or computer

to Please...

programs, that already were well known. Then they had to account for water droplets carried along in the airstream to figure out where they would hit a plane's wings, tail and engine inlets.

"It's like driving through a storm of bugs," Reinmann explains. "Bugs have inertia, so as they're carried with the air flow around your car, the heavier bugs hit the windshield while the lighter bugs go over or around." Water droplets also have inertia, so the largest droplets tend to travel straight ahead and run into the leading edge of an airplane's wings.

Richard Ranaudo, research pilot, and Thomas Ratvasky, flight test engineer, with the De Havilland DH-6 Twin Otter aircraft.

Once the Lewis scientists had a good grasp of the paths that water droplets follow, they proceeded to calculate the shapes that ice forms as it builds up on an aircraft. It was a complex exercise that considered both the weather conditions that lead to plane icing and the fundamental physics of the freezing process.

Icing takes place in "supercooled" clouds, where water remains liquid even though the air temperature is very cold—as low as minus 34 degrees C. When a plane flies through these clouds, water droplets hit the aircraft's surface and give up their heat to the surrounding cool air. The heat is carried away by the air flow.

That sounds relatively simple to compute, but Reinmann points out that there are many variables. For instance, if the air is really cold, the droplets freeze right away. When the temperature climbs up toward the freezing point, though, the water moves along the surface to an area of the wing where the air flow is faster before releasing its heat.

"So we take the air velocity and the air temperature, then calculate where the water's going to freeze and how much is going to freeze," says Reinmann.

Lewis' ice formation computer code—appropriately dubbed "LEWICE"—now has more than 40 users in government, industry and universities. Reinmann says one of the biggest recent achievements was to combine LEWICE, which can handle only two dimensions, with other computer codes to predict ice accretion on three-dimensional surfaces such as airfoils and swept wings. Eventually, he says, the 3-D version of LEWICE should be able to estimate ice buildup on a whole aircraft.

"Every aircraft that flies is likely to encounter icing sometime.... It's a problem that never goes away."

But even that achievement would be only halfway to the ultimate goal of letting aircraft fly safely in icing conditions as prescribed by federal air regulations. The Lewis researchers are now trying to model what ice does to a plane's aerodynamic qualities. It's a difficult task because the surface of the ice is rough, and even the most advanced computer programs have trouble simulating air flow over uneven surfaces.

"If you're talking about [understanding] how the ice affects the full performance of an aircraft, that's about five years away—but we're working these problems right now," Reinmann says. "We can't calculate every condition encountered in icing, but we can do a good job forecasting how an airplane will perform in some conditions, depending on the shape of the ice and how badly it distorts the plane's aerodynamics."

Obviously a computer program is only valid if it accurately reflects what happens in the real world. That's where experimental data from Lewis' Icing Research Tunnel comes in.

The motto of researchers at this facility—"We Freeze To Please"—reflects the

tunnel's ability to dial in the weather for any time of year. It is one of the few wind tunnels in the world that can simulate cold temperatures and vary the droplet size and water content. Its 1.83 x 2.74-meter test section is the largest of any closed-loop (recirculating air) refrigerated tunnel in existence.

The tunnel ranks among NASA's most used facilities. This year, says Lewis aerospace engineer Tom Bond, it will be used for more than 1000 hours of tests, running an average of about six hours per work day. In 1990, its peak year so far, the Icing Research Tunnel was booked for a remarkable 1330 hours.

"The reason the tunnel is so busy is that it generally handles small, relatively uncomplicated projects," says Bond. "About 30 percent of the tunnel time is devoted to in-house work on ice accretion physics. About 60 percent is direct support of our customers: the military, ice protection companies and just about every airframe manufacturer."

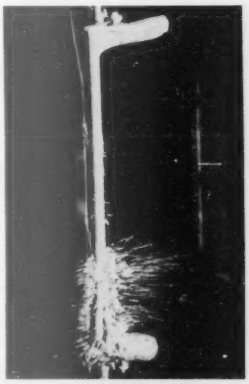
Icing tunnel researchers work closely with Lewis' computer experts to set up experiments that will model the desired phenomena. The data from tunnel runs are then plugged into computer simulations of icing encounters to prove and refine them.

Outside customers can book time in the Icing Research Tunnel under two kinds of agreements. If they want to keep test results completely proprietary, they have to bring their own hardware and personnel, do the tests themselves and pay for the tunnel time...at about $60,000 per week.

More common is an arrangement provided for by the U.S. Space Act, where no money changes hands and both sides share data from the tests. Typically, says Bond, the customer contacts Lewis about a year before the dates they want to reserve. NASA officials then consider whether the tunnel can handle the request and how the agency would benefit. If the proposal is cleared, NASA and the user define the instruments and hardware needed to get the best return for the least tunnel time.

"It's a public facility, so we work hard to accommodate most test requests," Bond notes.

John Reinmann, Chief, Icing and Cryogenic Technology Branch, sits in the control room of Lewis's Icing Research Tunnel.



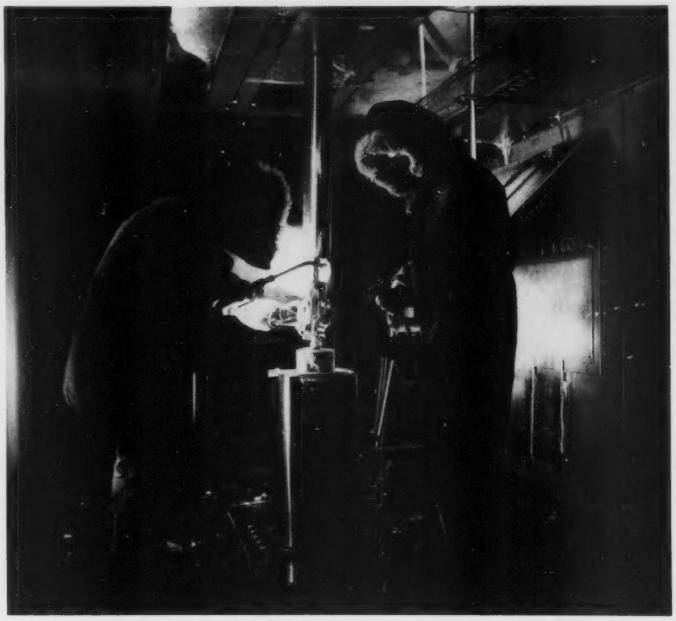
Ice particles come flying off the engine inlet component during activation of the expulsive de-icing system.

The Icing Research Tunnel has been used for many important programs. In a joint effort with the Air Force, NASA assessed eight designs for low-power de-icing systems and developed new test methods. Bond says one of those systems is already on an aircraft and another is very close to being commercialized.

Several years ago, NASA worked with U.S. helicopter companies to simulate icing during forward flight for the first time in this country. Reinmann says the firms were looking for ways to cut costs by using ground-based facilities; it costs up to $20 million to certify a helicopter design just by flying in natural icing conditions.

Reinmann believes the tunnel's most important role to date has been to help evaluate several "Type II" ground de-icing fluids used by European airports. In 1988 and 1990, researchers ran tests to see if the fluids—which let planes stay de-iced longer than American fluids do—affected an aircraft's takeoff performance. The results showed that experimental fluids had low aerodynamic penalties, and they were put into service in late 1990. "A new, very simplified acceptance test for de-icing fluids also came out of that work," adds Reinmann. "Now the fluid makers don't have to come in the tunnel with a $500,000 model for weeks on end."

Computer simulations and tunnel runs produce valuable data at a reasonable cost, but they have one drawback for aircraft manufacturers: The Federal Aviation Administration won't certify a design for icing conditions without actual flight tests. So Lewis also has a busy program of research flights. Since 1981, the center has flown 25 to 30 icing research missions a year with an ungainly DeHavilland Twin Otter, a light transport plane powered by two turboprop engines. The Twin Otter deliberately penetrates supercooled clouds and gathers data on ice formation with a battery of sophisticated instruments. Often, the plane flies with computer-designed styrofoam "ice" shapes mounted on its wings and tail to see how they affect aircraft handling.



Technicians use a steam wand to remove ice from an OH-58 helicopter tail rotor model after testing in the Icing Research Tunnel.

"Natural icing research is dangerous because there's the risk of accumulating too much ice and losing an engine," says NASA pilot Rich Ranaudo, who has been at the controls of the Twin Otter on many of its flights.

Lewis' northeast Ohio weather is perfect for icing research. On a typical flight, says Ranaudo, he guides the Twin Otter toward a location where conditions are right for ice to form. Then he dips into the cloud tops to build up different ice shapes while the plane's crew of scientists and engineers takes measurements. With ice still on the aircraft, he also does limited maneuvers to check the plane's performance.

Most of the flights with artificial ice shapes also take place in the Cleveland area. In mid-1992, however, Ranaudo and the Twin Otter operated for several weeks out of NASA's Wallops Flight Facility on the Virginia coast during a unique test program. The goal was to see how the styrofoam ice affected the plane "without engine effects"—Ranaudo's matter-of-fact way of saying that both motors were shut down.

Here, an engineer scrapes ice from the surface of a B1-B wing section after testing in the Tunnel.

According to Reinmann, the latest major icing challenge for NASA and industry is integrating ice protection into "laminar flow control" systems that remove the turbulent air rushing over an airplane's wing by siphoning it through tiny holes in a section near the leading edge to smooth out the airflow. The key to protecting the leading edge from ice may be just the opposite procedure—blowing hot air out of the holes.

There are two bottom lines to NASA's icing studies. One is pure economics: It's far cheaper to put a new aircraft through an icing encounter inside a computer or the Icing Research Tunnel than to fly it in natural icing conditions. Reinmann says the cost to "certificate" a jet transport can run up to $10,000 per flight hour. And the only helicopter now cleared to operate in icing conditions, the French Super Puma, took nine years—flying literally day and night—to complete its icing test program.

The real justification, though, is improving flight safety. Every few years, icing claims an aircraft and kills or injures its passengers. The people at Lewis want to do what they can to prevent it from ever happening again. •

Les Dorr is a regular contributor to the Magazine. His last article, on runway testing at Langley, appeared in the Summer 1992 issue.

Eulogy For a Pioneer

The Pioneer Venus Orbiter surpassed all expectations, and then some.

by Dr. Larry Lasher

Last October, planetary scientists said farewell to an old friend, the Pioneer Venus Orbiter (PVO), which burned up in the atmosphere of Venus after 14 years of loyal service and scientific discovery.

Periodic firings of thruster jets to raise the spacecraft's orbit had kept it alive as long as possible, but as the onboard hydrazine fuel became exhausted, gravity pulled the spacecraft inexorably down toward the planet. Even as its orbit dropped, the PVO was still returning data on the Venusian atmosphere. Although the information was valuable, project managers had mixed emotions knowing what lay

Due to a lack of photographic contrast, this page did not reproduce well.

in store for the spacecraft. "We spent some sleepless nights deciding just how deep to allow passage through the upper atmosphere," says Deputy Space Projects Chief and Pioneer Venus Project Navigator, Jack Dyer.

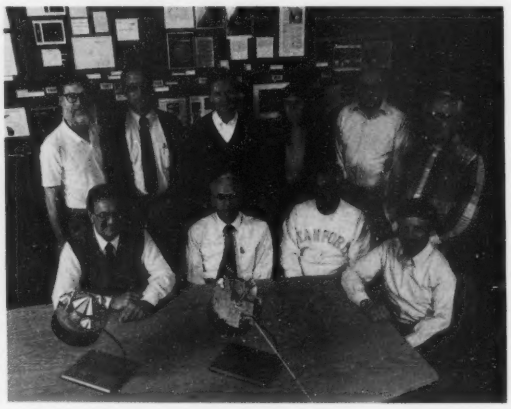
By that time, of course, the PVO had long ago outlived its nine-month design lifetime in Venus orbit. The 550-kilogram, drum-shaped spacecraft was launched in May 1978 and began circling Venus the following December. A companion multiprobe spacecraft had been launched that same August, with one large atmospheric entry probe and three identical small ones that took measurements for about an hour as they descended through the atmosphere on December 9, 1978. The probes were not planned to land on the surface because of the extremely high temperatures and pressures.

Pioneer, managed by Ames Research Center for NASA's Office of Space Science and Applications, accomplished one of its primary goals early in the mission by mapping more than 90% of the surface of Venus with a radar altimeter. This set the stage for much higher-resolution radar mapping by the Magellan spacecraft a decade later.

Other mission goals were to determine Venus' shape and internal density distribution, and to explore its clouds and atmosphere. The PVO also studied the interaction of the solar wind with the planet's ionosphere and upper atmosphere over many years, investigating how it varied with the solar cycle. In addition, Pioneer Venus was one of several spacecraft used to help determine the origin of gamma-ray bursts in the Universe.

David Lozier, the Pioneer Venus Project Flight Director, explains that to accomplish all these varied objectives, a highly elliptical orbit had to be chosen. The closest approach to Venus was at an altitude of only 150 to 200 kilometers, while the highest point of the orbit reached 66,000 km. During closest approach, the PVO sampled the ionosphere, the upper atmosphere and the so-called "bow shock" where the solar wind begins flowing around the planet. This was also the time when the PVO's radar instrument mapped the surface of Venus.

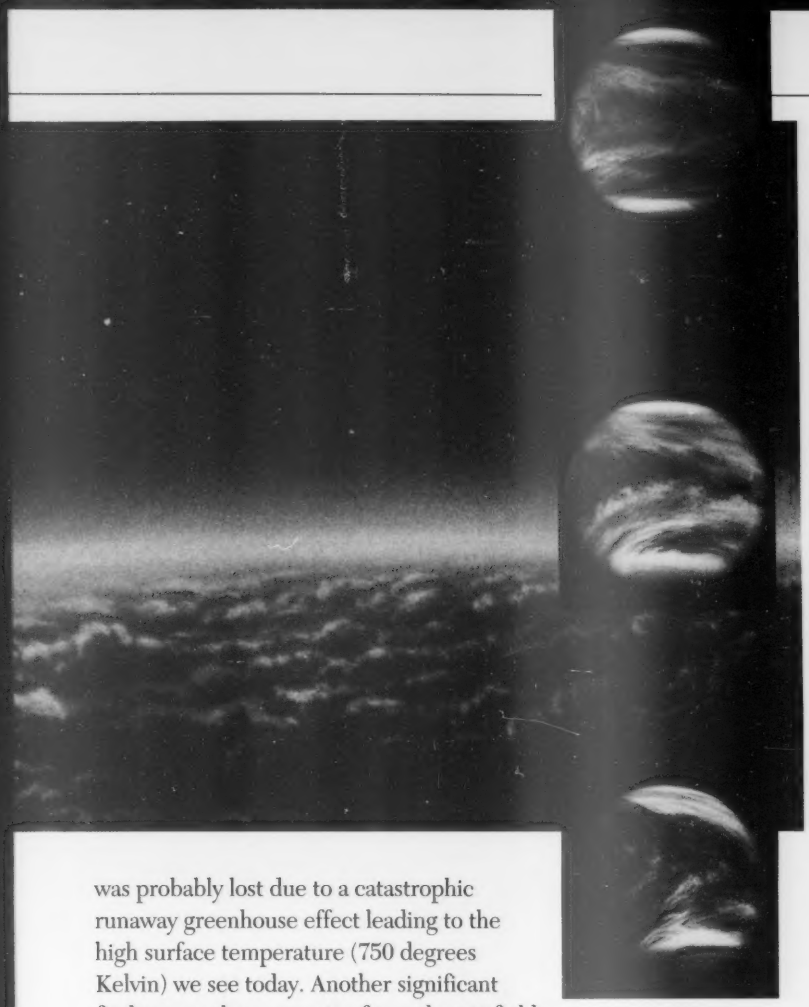
An artist's conception shows the Pioneer Venus Orbiter burning up during entry.



PVO staff left to right seated: Richard Fimmel, Jack Dyer, Larry Colin, and Larry Lasher. Standing left to right: Bob Jackson, Fred Wirth, Roger Craig, Marcie Smith, Jim Phillips, and Dave Lozier.

The high part of the orbit was used for taking full-disk images of the cloud-enshrouded planet. The spacecraft's 24-hour orbital period also matched the rotation of the Earth, which allowed consistent operations at the Deep Space Network tracking stations.

Larry Colin, Pioneer Venus Project Scientist, says that one of the most exciting results from the project was the discovery that Venus may once have had primordial oceans. If so, the water



was probably lost due to a catastrophic runaway greenhouse effect leading to the high surface temperature (750 degrees Kelvin) we see today. Another significant finding was the suggestion from electric field data that there was lightning beneath the thick Venusian clouds. This result is still controversial, though, as some scientists believe the observations can be explained by plasma instabilities in the ionosphere.

Even while the PVO was systematically gathering data from Venus, its ultraviolet spectrometer was taking the measure of whatever comets happened to wander into view. Jim Phillips, Pioneer Venus Project Trajectory Analyst, explains that this was accomplished by sending commands to the slowly spinning orbiter to change the tilt of its spin axis. Onboard thrusters would fire at a predetermined time in each spin to reorient the spacecraft to point its ultraviolet instrument at the comet instead of Venus.

Pioneer scientists say perhaps the most notable of these observations was of comet Halley as it rounded the Sun in February 1986. Viewing the famous comet from Earth was difficult at that time because it became lost in the glare of the Sun. But Venus was on the same side of the Sun and was closer to Halley when the comet reached perihelion, so the view from the PVO was much better.

These four images taken by the PVO Cloud Photopolarimeter show cloud patterns of Venus.

In the end, with its power running low and its orbit deteriorating, Pioneer Venus made its last contributions to science by exploring the same upper atmosphere that would cause its fiery death. Special preparations were required to accommodate PVO scientists during these final months of the mission. A computer network at Ames enabled the scientists to process data at mission control as well as to transmit data to their home institutions for more extensive processing.

On September 7, 1992, the orbit's low point, or periapsis, was raised by 20 km to about 155 km. After this first maneuver, the thrusters were fired every five days or so until October 7, when the spacecraft's fuel finally ran out. The Pioneer Mission Operations Center at Ames lost contact with the PVO at precisely 20:22 Greenwich Mean Time on October 8, bringing to a close one of NASA's longest and most successful planetary missions.

The words of Fred Wirth, Pioneer Venus Deputy Project Manager, sum up the feelings of those of us who participated in the project: "The 14-year flood of science data from Pioneer Venus has been particularly rewarding. The radar map of the Venus surface, the characterization of the bow shock and the ionosphere, pictures of the cloud cover and the glowing ultraviolet image of Halley's comet somehow made it all worthwhile. The Orbiter may be dead, but the legacy of scientific data it leaves behind will continue to nourish mankind in its quest for knowledge for many years to come." •

Larry Lasher is the Pioneer Missions Science Chief at the Ames Research Center.

Langley

2017: An Earth Odyssey

Langley Research Center director Paul F. Holloway's business card was tucked into it. So was a pack of tomato seeds that had spent six years in space on the Long Duration Exposure Facility. More than 50 other items, from a space structure joint to castings of wind tunnel models, were committed to history in December when Langley buried a time capsule as the last official act of its 75th anniversary celebration.

"I'd really like to be here when this thing gets opened up—maybe I will be," said Langley acting director H. Lee Beach Jr. as workers lowered the polypropylene container into a concrete chamber and sealed it with a brass cover. The capsule, due to be unearthed at intervals of 25, 50 and 100 years, is about the size of a 55-gallon drum. It lies below a "span" sculpture made of aluminum with a finish of weathered bronze, which symbolizes the union of the center's past and future missions. A letter inside the capsule will greet whomever opens it on Langley's centennial anniversary: "We salute you, our posterity, and hope we helped deliver a creative, productive and sound Langley Research Center to you in 2017." •

Langley's acting center director, H. Lee Beach Jr., looks on as workers lower the time capsule into the ground.

Ames-Dryden

Thirtysomething

During his more than three decades of service to NASA, Ted Ayers was associated in some way with every new aircraft built in this country. It was "a fantastic career for someone who grew up on a cattle ranch in Nebraska," he says. Ayers, 57, retired in January as deputy director of the Dryden Flight Research Facility. He started his NASA career at Langley in 1961 as an aerospace technologist, and spent ten years as a research engineer working with that center's 8-foot transonic wind tunnel. In 1971 Ayers was named manager for aerodynamics for the

Ted Ayers

NASA Advanced Transport Technology Program. He transferred to Dryden in 1976 as chief of the aeronautics branch until being appointed deputy director in 1982. Dryden director Ken Szalai said in praise of Ayers, "Ted is an exceptionally talented person who has been totally dedicated to the people and mission of Dryden." •

Goddard

And the Winners Are...

Goddard Space Flight Center director John M. Klineberg announced in December the 1992 winners of the Goddard Excellence Award for quality and productivity. They are Motorola Inc.'s Strategic Electronics Division of Chandler, Arizona, and Stanford Telecommunications Inc.'s Systems Engineering Division of Reston, Virginia. The award recognizes model organizations that practice the philosophy of continuous improvement and who are willing to share their information and achievements with others. •

Klineberg, right, presents award to Motorola's Napoleon Hornbuckle.

Stennis

Eyes on Belize

When the government of Belize wanted help in converting the northern part of Ambergris Cay—the largest of more than 200 islands that hug the Central American nation's coast—into a resort area, where did it turn? NASA, of course. Stennis Space Center's Visiting Investigator Program (VIP), developed by the center's Science and Technology Laboratory, allows non-NASA users to take unique aerospace capabilities such as satellite remote sensing and apply them to commercial projects.

Because Ambergris Cay is rich in environmental and historical value, the Belizian government did not want to destroy it in the process of developing the island for tourists. So Engineering Plus Inc., of Meridian, Mississippi, asked Stennis to provide scientific and engineering expertise as well as satellite data. The company will use NASA-developed remote sensing technology and a Geographic Information System (GIS) to identify wetlands, land use patterns and vegetation on the island. Through Stennis's VIP program, industries conduct research that can lead to new or improved products, processes and services that benefit the company, the public and NASA. •

Marshall

Ms. Bankston Goes to Washington

Cheryl Bankston, a co-op employee at the Marshall Space Flight Center, came to Washington in February to receive special recognition for her academic achievements at the University of Alabama in Huntsville. Bankston, who was selected as one of 20 outstanding scholars nationwide by *USA Today*, credits her achievement not only to her work at UAH but also to her experience at Marshall. Bankston recently was assigned to the Optics Branch in the center's Information and Electronics Systems Laboratory.

"The people in the Optics Branch are a very motivated group, and [working with them] has made me excited about my future at Marshall," she says. "There's no better education than being able to take what you're learning in school and apply it the next day in the work environment."

Bankston plans to receive a bachelor's degree in electrical engineering from UAH and to continue working for a master's degree in 1994. After that—who knows—she may wind up with a full-time career at NASA. •

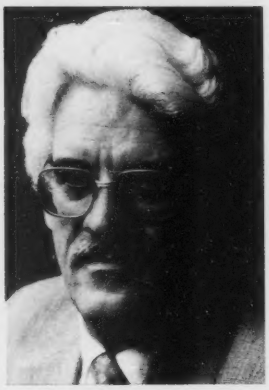
Kennedy

Rust Sometimes Sleeps

If you live in the harsh seaside environment near the Kennedy Space Center, chances are you know all about rust—on your once shiny car, your outdoor metal lights and your backyard grill. Thanks to the efforts of Karen Thompson, a chemist at Kennedy's Materials Analysis Laboratory, a new protective coating may be able to beat that rust, or at least slow it down.

Every time the Space Shuttle takes off, the reaction of solid and liquid propellant exhausts produces a corrosive acid. After each launch, many areas at the pad have to be sandblasted and repainted, which is why KSC scientists are hoping to come up with a coating that could withstand the corrosive effects of at least two Shuttle launches. Kennedy is a leader in the field of electrically conductive protective coatings, and Thompson says that this is the first time these coatings have been used for corrosion control on metals. "This coating technology has sparked a great deal of interest in industry. We have been contacted by automobile, aerospace and oceanic oil-drilling companies," says Thompson. •

Ask not what the Universe can do for us. Ask what we can do for the Universe.



Spaceflight and the New Enlightenment

by Jesco von Puttkamer

The future will confront politicians and managers with gigantic new challenges of unprecedented complexity. Titanic information flows, threatening to drown us, will make it increasingly difficult to extract urgently needed data. Even today, new decision-making processes and management methods are being tried out of fear that we will become paralyzed by the sheer volume of information.

At the same time, spaceflight, with its strong emphasis on knowledge, experience and global perspective, is already providing the intellectual tools and the cultural equipment required to tackle the megaproblems of the coming century. Among these tools are network thinking, more efficient use of scarce resources and consumables, and world-wide cooperative partnerships in global problem solving.

Unfortunately, what is still being taught in schools and universities is a collection of separate individual subjects, systematically ordered and neatly departmentalized. In the real world, these "separate" disciplines are tightly interconnected. This is also true for the great problems confronting us today and in the coming decades. To deal with them, we need a new frame of mind that shifts the emphasis from individual subjects to the interactions and relationships between them. Human spaceflight has pioneered this way of thinking in practice and continues to do so. A truly groundbreaking venture, it has provided an example of the systems approach that people of the future will need.

Just as the knowledge revolution that began in 17th century France, England and Germany opened the door to rational, liberal, humanistic and scientific thinking in the 18th century, so our new space perspective may carry this process of enlightenment an important step further. Our belief that the Sun revolves around the planets died with Copernicus, and so our outdated ideas about ecology, government and other concepts mired in 19th and 20th century thinking must also progress. Spaceflight—whether human or robotic, in near-Earth orbit or headed for Mars—can provide us with a metaphor for that future. It stands in the great tradition of human exploration, pushing back not only concrete, physical frontiers, but also the conceptual frontiers of the imagination.

Eventually, though, we come to ask *why* humankind should explore space. The question originates not with us but with the Universe itself, and clearly it cannot be completely and rationally answered. Its deeper understanding comes not from finding a clear-cut, unambiguous solution to the riddle, but from the process of consciously pursuing it.

Likewise, the question, "What *use* is spaceflight to us?" is equally impossible to answer. Where do we even get the cocky confidence that spaceflight should have anything to do with benefits to humanity in the first place? Is that not merely an assumption—however natural and logical it may seem to us—by a species that appeared on the scene only a cosmic instant ago? Might not one turn the question around and ask instead, "What is humanity's use to the Universe?" When people of the future ask this question in all seriousness, perhaps our collective mind will have ascended another step.

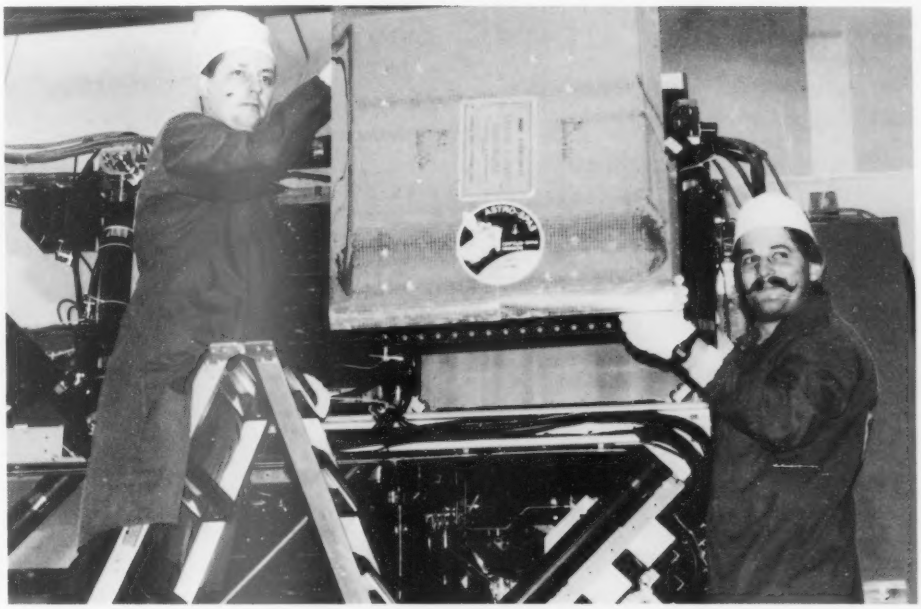
The answer is intrinsic to our own enlightenment, which is why there must be spaceflight. In the course of this lengthy, drawn-out process of growing up, newer and deeper insights will unfold, and humans will content themselves less and less with simple answers. The living planet Earth, through this questioning self-reflection, will become a more conscious world. And the physical, inanimate entropic Universe could thereby evolve to become a conscious, anentropic Universe that may represent the final answer in itself. •

Jesco von Puttkamer is a Strategic Planner in the Policy and Plans Division of the Office of Space Flight.

LAUNCHES

• STS-57—For this 7-day mission, Endeavour will carry Spacehab-1 and Eureca-R.

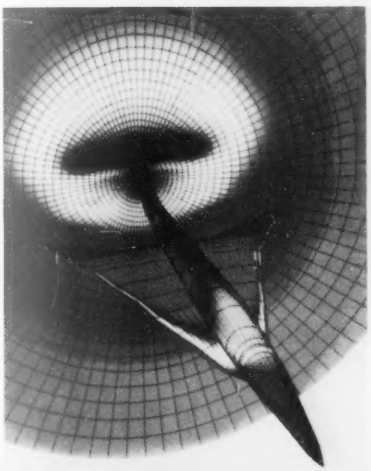
• STS-51—The ACTS and ORFEUS/SPAS will be cargo bay payloads on the orbiter Discovery.



EVENTS

10
JUNE

The 1993 Paris Air Show will open in Paris at Le Bourget Airport through June 20.



IN OUR NEXT ISSUE

Exploring asteroids: from space and from the ground.

NASA

National
Aeronautics and
Space
Administration

Congressman Louis Stokes of Ohio speaks to parents, teachers, and students while visiting Anton Grdina Primary Achievement School in Cleveland last October.